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The Philippine Agriculturist

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VOLUME XVIII

JUNE, 1929, TO MARCH, 1930
(Complete in ten numbers)

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ERRATA

Page 356, line 6 from bottom, "*Bacillus coli* Emmerich" should read "*Bacillus coli* (Escherich) Migula".

Page 356, lines 17 and 18 from bottom, "courses on diseases of vegetables and diseases of fruit" should read "courses on diseases of garden crops and diseases of fruits".

Page 379, line 4 from bottom, "Cavannaugh" should read "Cavanaugh".

Page 437, line 11 from top, "Tax at 88%" should read "Tax at 0.88%".

Page 448, paragraph 5, first three lines should read "The board of directors of the association is composed of five members elected by the stockholders. The members of the board of directors elect their own chairman who is also the president of the association. The secretary who may or may not be a member of the board of directors is elected by this board".

Page 581, last line at bottom of page and page 582, line 15 from top of page, and page 589, lines 11, 14, and 17 from top of page—"Engle" should read "Engel".

Page 592, line 4 from top, "72.8" should read "72.6"; line 5 from top, "4.2" in both cases should read "4.3".

Page 594, table 2, after "San Carlos" in table heading there should be [a]; after "Balungao" in table heading there should be [b].

Page 596, table 5, column 4, "68.2" should read "68.8"; "44.0" should read "44.3"; "47.0" should read "47.1"; "6.5" should read "7.2".

Page 596, table 6, column 2, "2.8" in both cases should read "2.9"; column 2, "2.3" in both cases should read "2.4".

Page 597, table 8, column 2, "1,649.16" should read "1,649.17"; column 3, "551.51" should read "551.52"; column 4, "773.20" should read "773.23"; column 4, "766.26" should read "766.25"; column 6, "1.24" should read "1.25".

Page 601, table 13, column 7, "0.0" should read "2.0".

Page 602, table 15, column 7, "per cen" should read "per cent".

Page 603, table 16, column 2, "72.8" should read "72.6"; column 2, "4.2" in both cases should read "4.3".

Page 607, line 14 from bottom, "157 (60 quarts)" should read "*57* 1. (60 quarts)".

NOTE:—The article "Study of the standard of living in the towns of Balungao and San Carlos, Pangasinan" was published after the author and adviser had left the College. Hence, they did not make a final revision of the paper. This accounts for the errors, mostly in computation, which are here corrected.

G. O. OCFEMIA, *Index Editor*.

MISS YULE AND PHILIPPINE TECHNICAL LITERATURE

We are in the habit of taking too many things for granted. Conveniences intimately associated with the routine of daily life are often accepted as matter-of-fact commodities which are but an incident to our inherent right to live comfortably. Ingenious tools are made use of, and occasionally abused, and frequently no conscious thought is given to their existence, so quickly is man's mind inured to the marvels of many of the products of creative arts and sciences that go to make this world a more pleasant place to live in. But withdraw one of these familiar appurtenances, or even temporarily render it unserviceable, and right away we become possessed by a sense of appreciation in feeling that we miss something indispensable.

At the close of the past academic year, Miss Yule left to enjoy abroad one year of her well earned vacation. To be sure, gratitude for her useful service was not wanting while she was still on active duty at the College. This appreciative feeling, however, has become keener and more spontaneous after she has gone.

Miss Yule has probably done more than anybody else to raise the standards of Philippine agricultural literature to its present measurably improved level. After she took hold of the *Philippine Agriculturist* she made of it a uniformly meritorious scientific journal during her incumbency as editor. She has been responsible to a large extent for developing the art of technical writing at the College of Agriculture to a degree which now almost amounts to that of an exact science. The book on the preparation of manuscript of which she is joint author with Dr. Sam F. Trelease veritably brought order out of chaos in the form and presentation of the graduating theses of our students and even the scientific papers of many of the more seasoned faculty members.

One of the most serious drawbacks of technical workers is that they frequently do not know how to translate their thoughts to paper in well arranged and acceptable language. Criticisms of this nature have often been aired in the United States against American technical men, to whom English is the mother tongue. The Filipino technical worker labors under a double handicap; he is a technical man, usually with a necessarily limited literary training and he has to write his reports in English, which is not his mother tongue. Under Miss Yule's guidance both obstacles have proved less and less difficult to overcome. Indeed, Miss Yule has to become an institution. Her colleagues have learned instinctively to turn to her for piloting whenever they find themselves lost in the intricacies of technical writing.

THE PHILIPPINE AGRICULTURIST, VOL. XVIII, NO. 1, JUNE, 1929.

THE EFFECTS OF DRIED SHRIMPS AND FISH MEAL AS SUPPLEMENTS IN RATIONS FOR EGG PRODUCTION[1]

F. M. FRONDA
Of the Department of Animal Husbandry

WITH TWO CHARTS

It has long been recognized that protein concentrates in some form should make an essential supplement in rations for egg production. Because of the value attached to these supplements, extensive investigations along this line have been conducted in many places in different parts of the world. The many reports on the results of the earlier studies on egg laying rations that have been published are valuable evidences of these efforts to aid the poultryman in solving his most important problem in producing eggs, that of feeding.

Because of their source, protein concentrates are the most expensive part of rations for egg production. For this reason, the Philippine poultry raiser is faced with the problem of where he can get these essential protein supplements in quantities large enough to enable him to feed his flocks properly and economically. Fronda (1919) and Frigillana (1923) demonstrated that fresh snails may be economically fed to laying hens, and Goseco (1920) fed them profitably to laying ducks. Moreover, local duck raisers depend entirely upon this food to help increase egg production. The difficulty with this feed, however, is that it is bulky, the edible portion being less than the waste. Also, it has to be fed fresh, incurring much labor in gathering the snails daily in a quantity sufficient for a flock of average size. As snails can be dried only with great difficulty, they have to be gathered daily if continuous or uninterrupted egg laying is to be maintained.

Fresh shrimps, another protein concentrate, form a part of rations given to young ducklings and to growing poults. It was not till the latter part of 1922, however, that the writer thought of using dried shrimps as a protein concentrate for supplementing rations for laying hens. Two advantages of shrimps over the snails are that they are procurable in larger quantities and can be dried easily. These advantages make it possible to store dried shrimps in quantities large enough to insure a continuous supply for a flock of any size throughout the year. The excellent effects of dried shrimps when used as a supplement in rations for laying hens was shown by Serrano (1928). Santiago (1926) demonstrated that dried shrimps may be profitably used also as a supplement in rations for growing barrows.

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[1] Experiment Station contribution No. 600. Received for publication September 10, 1928.

It was only two years ago, 1926, in seeking additional sources of these essential supplementary feeds, that it was found that a certain product called "fish meal" or more specifically, "herring meal", is being sold in Manila for fertilizer for vegetable gardens. Fish meal is an imported by-product of the fish oil industry, and on inquiry it was ascertained that the product consisted of whole fish ground up. The "meal" has an agreeable odor and it would seem that it may be useful for poultry feeding. It can be easily and safely stored and unlike the dried shrimps, ants do not bother it. As the fish meal is in ground form, it can be readily mixed with the mash without further preparation. Because there is always a demand for the "meal" for fertilizer, a continuous supply in the Manila market is fairly well assured.

The analyses of each of these three feeds snails, shrimps, and fish meal were supplied by the Department of Agricultural Chemistry of this College (see Table 1). These analyses give a very good idea as to the respective proximate feeding values of the products. The dried shrimps that were analyzed were in the form in which they are stored in the feed storeroom of the Department of Animal Husbandry. The fish meal sent for analysis was taken from the first few sacks bought for feeding trial. The snails were fresh.

TABLE 1

Analyses of fresh snails, dried shrimps, and fish meal

	FRESH SNAILS	DRIED SHRIMPS	FISH MEAL
	per cent	*per cent*	*per cent*
Shell	51.56	——	——
Meat	48.44	——	——
	.....		
Moisture	78.22	14.55	9.56
Fats (ether extract)	0.75	2.61	2.53
Ash	6.06	19.73	18.11
Protein (N×6.25)	7.62	55.61	57.99
Crude fiber	——	4.24	0.23
Carbohydrates (N.F.E.)	7.31	3.26	11.58

This table shows that dried shrimps and fish meal are practically the same in their composition. Fresh snails, on the other hand, have too little feeding value when their bulk is taken into consideration. This is the reason that in most cases fresh snails may not be used for extensive feeding of large flocks of chickens.

In the study here reported, the value of dried shrimps and of fish meal when used as supplements in rations for egg production were compared. Four lots each containing twenty Cantonese pullets were fed for one year with the regular College rations of one part grain—a mixture of corn and palay—and one part mash containing rice bran, corn meal, and copra meal.

Two of these lots were given a supplement of dried shrimps to the amount of five per cent and ten per cent of the ration respectively. Two others were given a supplement of fish meal, one of which was five per cent of the ration and the other ten per cent. A fifth lot, in which neither concentrate was added was used as a check. This check lot received a ration similar to that which was reported by Crucillo (1926) to contain the amount of copra meal in the most efficient proportion of the ration.

As has been indicated, the grain feeds received by all these lots were the same. The limiting factors, therefore, were confined to the mash mixtures. The different mash mixtures were as follows:

LOTS	INGREDIENTS [a]				
	Rice bran	Copra meal	Corn meal	Dried shrimps	Fish meal
Check	3	5	2	—	—
1	4	3	2	1	—
2	4	3	2	—	1
3	4	3	1	2	—
4	4	3	1	—	2

[a] Given as parts by weight.

Perhaps a word or two may be necessary to explain why these proportions were selected in this study. In the first place, the check lot, as has been stated, was adapted from the recommendation of Crucillo (1926) as to the amount of copra meal that may be given most profitably to laying hens. The present regular laying mashes in the College are of two kinds: (1) containing only five per cent of dried shrimps in the entire ration, similar to that given in lot 1, and (2) containing ten per cent of dried shrimps, similar to that given in lot 3. The first of these is our regular laying mash, and the second one is given to the birds when it is desired to stimulate them to lay eggs, in other words, it is a forcing mash. These proportions were used in this experiment so that whatever good results may be obtained with the fish meal may be readily and directly applied in the feeding of the laying flocks. This condition should be kept in mind when comparing the figures given in this paper, for otherwise the results may be misleading and may be improperly interpreted.

The Cantonese birds used had similar breeding, and were hatched during the same season of the year. When the lots were formed, the birds were selected at random. They were weighed at the beginning and at the end of the experiment. Records were kept of the amount of feeds consumed and of the number of eggs laid by each lot. The cost of the feeds and the total value of the eggs produced were determined to find which ration proved economical. Mortality records were also kept.

The prices of the different rations used were also computed. The grain ration was uniform in all the lots; the cost was ₱0.088 a kilogram. The cost of the different mashes, however, varied, depending upon their content of the protein supplements. The ration for the check lot was the cheapest, as this lot contained neither the dried shrimps nor the fish meal supplement.

TABLE 2

Cost of one kilogram of the rations used in the different lots

LOT	KIND AND AMOUNT OF SUPPLEMENT	GRAIN	MASH	COST OF ONE KGM. OF RATION
		centavos	*centavos*	*centavos*
Check	None	8.8	6.65	7.750
Lot 1	Dried shrimps, 5 per cent	8.8	7.63	8.215
Lot 2	Fish meal, 5 per cent	8.8	7.46	8.140
Lot 3	Dried shrimps, 10 per cent	8.8	9.01	8.950
Lot 4	Fish meal, 10 per cent	8.8	8.67	8.735

RESULTS

The results obtained in this study are given in tables 3, 4, 5, 6, 7 and 8. Table 3 gives the weights of the chickens at the beginning and at the close of the experiment. Table 4 gives the mortality of the hens in the different lots; table 5 the amount and total value of the feeds consumed; table 6 the percentage of egg production of the different lots; and table 7 the total number and values of eggs produced. The relative cost of feeds consumed and the total value of eggs produced together with the profits above the cost of feeds for the different pens are given in table 8.

Weights of the birds. The birds used in the study were pullets and had not quite reached their maximum weight, consequently all of them had increased in size at the close of the study. The least increase, however, was recorded in the check lot, where no protein supplement was added to the ration. Larger birds were produced in the five per cent dried shrimp lot than in any of the other lots. This result may have been partly due to the fact that the birds in this lot were slightly larger at the beginning than those in lots 2, 3, and 4. Although the birds in the check lot and lot 1 did not significantly differ in size at the beginning of the experiment, and in spite of the heavier egg production in lot 1, the birds in this lot were much larger at the close of the study. The birds in lots 3 and 4 were practically the same size, but if the egg production of these lots is considered in this connection, the dried shrimps may be adjudged to be a better supplement than the fish meal. Also, the appearance of the birds at the close of the study was practically the same in all of the lots. With swine, Ashbrook (1917) reported that both tankage and fish meal produced exceptionally good daily gains and at the same time maintained thrifty growth. Under the conditions of this experiment, it may also be concluded that in this regard, fish meal compares very favorably with dried shrimps.

Mortality of the hens. By reference to table 4, it may be seen that with the exception of the check lot, the mortality in all the other lots was within the normal range for laying hens. It is of interest to note that no mortality was recorded in lot 4, and only one death in lot 3. Both of these lots received the protein supplements in the proportion of ten per cent of the ration Both kinds of protein supplements, in general, probably helped reduce the mortality in all the lots given supplements. The twenty-five per cent mortality in the check lot is certainly significant.

Feed consumption and egg production. Efforts were exerted to have the birds consume one part of grain to one part of the mash feed, so that the consumption of these feeds was practically the same in all lots, with the probable exception of the check lot and lot 4, where the birds tried to consume more of the mash than of the grain. No significant difference was observed in the total amount of feeds consumed, but the difference in the total value of these feeds should be expected on account of the differences in the amount of the protein supplements in the ration which also affected the value of one kilogram of the ration.

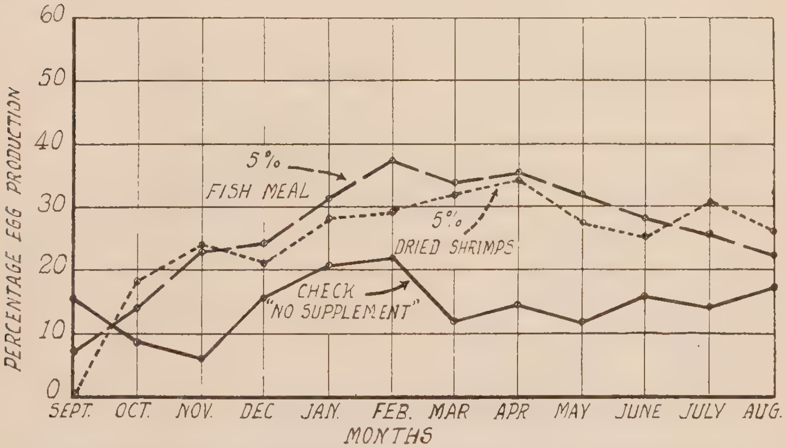

Chart 1.—Egg production in check (no-supplement) lot, compared with those of lots with supplements.

The percentage of egg production given in table 6 is graphically represented in charts 1 and 2. Study of these charts will show that although the no-supplement lot began with a high percentage of egg production, about 15 per cent, it fell below the other lots in the following months, and remained below throughout the year. The five per cent lots, both dried shrimps and fish meal, have practically the same percentage egg production, but lot 3 (ten per cent dried shrimps) was better in almost all months than lot 4 (ten per cent fish meal). In the total egg production, a similar tendency was shown. The no-protein supplement lot produced the least number of eggs, and the ten per cent dried shrimp lot produced the most. Comparing the five per cent lots, both dried shrimps and fish meal, the total number of eggs produced was a little in favor of the fish meal lot, although the difference is perhaps not significant. In the ten per cent lots, however, the fish meal lot produced a significantly smaller number of eggs than the dried shrimp lot, a condition quite contrary to general expectation. Just what the reason is for this particular difference at this level, the writer cannot ascertain.

From table 8, it may be seen that the income from eggs above the cost of feeds ranged from ₱24.26 in the no-supplement lot to ₱63.96 in the five per cent lot of the fish meal supplement. Comparing lots 1 and 2, there is a difference of ₱5.74 in the profits above the cost of the feeds in favor of the fish meal. Although the difference in the number of eggs produced is perhaps not very significantly in favor of the fish meal lot, when the values of the feeds consumed and of the eggs produced are considered, the difference becomes significant owing to the lower cost of the fish meal ration. Considering the advantages of the fish meal over the dried shrimps, as already given, it would appear that fish meal may be preferable to dried shrimps at this level.

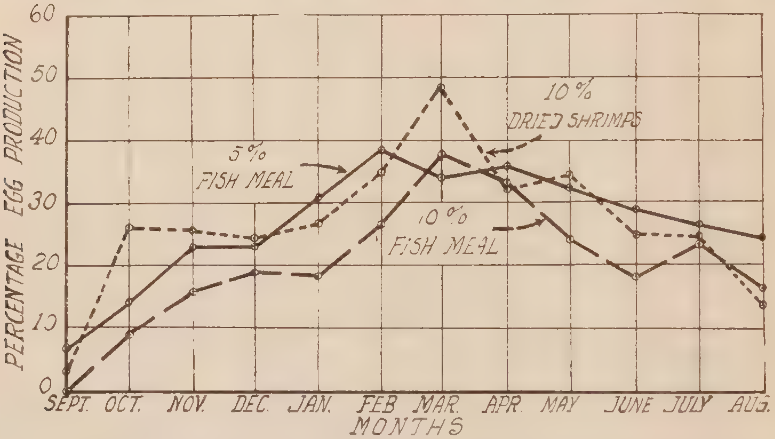

Chart 2.—Egg production in lot 2 (5 per cent fish meal lot) compared with lots 3 and 4, 10 per cent dried shrimps and 10 per cent fish meal lots, respectively.

At a higher level of intake, however, the ten per cent fish meal was almost fifty per cent inferior to the ten per cent dried shrimp lot, the difference between these two being ₱23.97 in favor of the dried shrimp lot. Even if the lower price of the fish meal is taken into account this difference may be considered very highly significant. This result, as already stated, is contrary to expectation, as there is apparently no reason why it should be so. The unexpected large amounts of salt crystals that were in the fish meal may have caused an unfavorable effect on the egg production of the birds. This unknown salt was found in rather large crystals mixed with the fish meal. Another test may be necessary to verify these results before conclusive recommendations can be given.

The largest profit per bird over the cost of feeds was obtained in the five per cent fish meal lot. In the dried shrimp lots which were a close second, the ten per cent dried shrimp lot was only ten cents better than the five per cent dried shrimp lot. It would appear that when the average profit per bird is considered, five per cent of either dried shrimp or fish meal is sufficient in the ration for egg production. But when the cost of production is not considered at all, and the number of eggs produced is the only guide in feeding, the dried shrimps may be increased to ten per cent. Another test will be necessary before definite recommendations may be made regarding the feeding of fish meal at a higher level of intake than five per cent.

SUMMARY OF CONCLUSIONS

1. Both dried shrimps and fish meal produced satisfactory results when used as supplements in laying rations in the proportion of five per cent of the ration.
2. When given in the amount of ten per cent of the ration, the hens were stimulated in their egg production, but the income from this increased number of eggs does not increase at the same rate.
3. Under the conditions of the experiment, it was found not profitable to increase the fish meal supplement to ten per cent of the ration. When fed at this level, the profits per bird above the cost of feeds was not greater than that of the no-supplement lot.
4. The amount of feeds consumed in all lots was practically the same.
5. The no-supplement lot, and the lot receiving ten per cent fish meal supplement tended to consume more of the mash than of the grain.
6. Both dried shrimps and fish meal produced well developed yearlings, which in all cases were similarly attractive and vigorous.
7. When the profits derived from feeding are considered, five per cent of either dried shrimps or fish meal is sufficient in rations for egg production.
8. Feeding at higher levels may increase the number of eggs produced, but because of the increase in the cost of the ration, the profits derived from the feeding operation does not increase proportionally.
9. The addition of protein supplements in the rations lowered the mortality of the birds.

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TABLE 3

Average weight of hens

LOTS	AVERAGE WEIGHT AT THE BEGINNING OF THE EXPERIMENT	AVERAGE WEIGHT AT THE CLOSE OF EXPERIMENT	DIFFERENCE
	grams	*grams*	*grams*
Check No supplement	1037	1193	156
Lot 1 5% dried shrimps	1045	1300	255
Lot 2 5% fish meal	980	1208	228
Lot 3 10% dried shrimps	1023	1250	227
Lot 4 10% fish meal	1033	1277	244

TABLE 4

Percentage mortality of hens

LOTS	NUMBER OF HENS AT BEGINNING OF EXPERIMENT	NUMBER OF HENS AT CLOSE OF EXPERIMENT	PERCENTAGE MORTALITY
Check No supplement	20	15	25
Lot 1 5% dried shrimps	20	18	10
Lot 2 5% fish meal	20	17	15
Lot 3 10% dried shrimps	20	19	5
Lot 4 10% fish meal	20	20	0

TABLE 5

Feed consumption of the different lots

LOTS	TOTAL GRAIN	TOTAL MASH	TOTAL VALUE
	kg.	*kg.*	*pesos*
Check No supplement	267.8	291.5	32.50
Lot 1 5% dried shrimps	271.7	279.5	45.25
Lot 2 5% fish meal	267.2	272.7	43.84
Lot 3 10% dried shrimps	267.6	273.2	48.16
Lot 4 10% fish meal	265.6	282.1	47.83

TABLE 6

Percentage egg production

MONTHS	CHECK	LOT 1 5% DRIED SHRIMPS	LOT 2 5% FISH MEAL	LOT 3 10% DRIED SHRIMPS	LOT 4 10% FISH MEAL
September	15.1	0	6.8	2.5	0
October	8.4	18.2	13.7	26.6	9.4
November	6.5	23.5	22.9	26.4	15.3
December	15.8	20.5	23.3	23.7	19.0
January	20.1	28.5	30.4	27.0	18.7
February	21.0	29.3	37.8	34.6	26.8
March	11.2	31.5	33.8	49.0	38.7
April	14.7	34.4	34.9	31.6	23.0
May	11.3	27.8	31.7	33.4	23.4
June	16.0	25.6	28.8	24.2	18.7
July	13.5	30.4	25.6	23.4	22.4
August	17.3	25.8	23.6	12.7	15.2

TABLE 7

Egg production and value of eggs produced

LOTS	TOTAL NUMBER OF EGGS LAID	TOTAL VALUE OF EGGS PRODUCED @ 72 CENTS A DOZEN
		pesos
Check No supplement	946	56.76
Lot 1 5% dried shrimps	1729	103.74
Lot 2 5% fish meal	1780	106.80
Lot 3 10% dried shrimps	1865	111.90
Lot 4 10% fish meal	1460	87.60

TABLE 8

Relative cost of feed consumed and of eggs produced in the year

LOTS	TOTAL VALUE OF FEEDS	TOTAL VALUE OF EGGS	PROFIT ABOVE COST OF FEEDS	PROFIT ABOVE COST OF FEEDS PER HEN
	Pesos	*Pesos*	*Pesos*	*Pesos*
Check No supplement	32.50	56.76	24.26	2.04
Lot 1 5% dried shrimps	45.25	103.74	58.49	3.25
Lot 2 5% fish meal	43.84	106.80	63.96	3.76
Lot 3 10% dried shrimps	48.16	111.90	63.74	3.35
Lot 4 10% fish meal	47.83	87.60	39.77	1.99

STUDIES ON CEMENT MORTARS AND CONCRETE, I: EFFECT OF COMMON SALT ON THE TENSILE STRENGTH OF CEMENT MORTARS[1]

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WITH ONE CHART

The effect of sodium chloride as an admixture in concrete has been the subject of study for some time among investigators. The results and conclusions are many and varied.

In temperate countries, the practice of adding salt to the mixing water to lower the freezing point is not uncommon. The practice, however, is generally discriminated against in building codes of most cities.

Abrams (1924)[3] found that waters containing more than 5 per cent of common salt gave strength-ratios less than 85 per cent, which was considered the lower limit for acceptable mixing waters. He further found that concrete mixed with sea water (about 3.5 per cent salts, mostly sodium chloride) and cured in a moist room gave higher strengths than fresh-water concrete at ages of 3 to 7 days; at 28 days and over, the strength-ratios ranged from 80 to 88 per cent. He also found that concrete, made with solutions of common salt and cured until test in a moist room, showed a slight increase in strength at 3 days for solutions of 10 per cent and less. Solutions of low concentrations (1 and 2 per cent)also showed slight increase in strength at 7 days. After 7 days, he found that all concentrations gave material reductions in strength.

MATERIALS

Aggregates

Cement. Portland cement, "Apo" brand, was used in the present study. This was stored in the laboratory after acquisition, and used a short while after. It was found to be sound upon test in the laboratory. The following analysis of the cement was obtained from the Philippine Bureau of Science.

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[1] Experiment Station contribution No. 601. Received for publication March 25, 1929.

[2] Thesis student in the Department of Agricultural Engineering working with Dr. Gordon.

[3] Abrams, Duff A. 1924. Tests of impure waters for mixing concrete. Structural Materials Research Laboratory, Lewis Institute Bull. 12: 1–46.

CHEMICAL ANALYSIS OF APO CEMENT

	per cent
Loss by ignition	1.95
Silica (SiO_2)	21.70
Iron oxide (Fe_2O_3)	3.35
Aluminum oxide (Al_2O_3)	6.15
Calcium oxide (CaO)	64.00
Magnesia (MgO)	0.44
Sulphuric anhydride (SO_3)	1.34

PHYSICAL TESTS

	per cent
Fineness, through 200 mesh sieve	85.00
Specific gravity	3.10
Time of setting—initial	3 hr. 00 min.
final	6 hr. 50 min.
Soundness test	Good
Tensile strength of mortar (1 part cement and 3 parts of Standard Ottawa sand by weight)	
7 days	320 lbs. per sq. in.
28 days	437 lbs. per sq. in.

Sand. The natural sand obtained from Bay, Laguna, was used in this study. The sand was passed through a 12-mesh sieve, and then washed clean of organic matter with rain water.

Admixture

Common salt (NaCl) was the admixture used. Various solutions were prepared and later analysed for NaCl content in the Agricultural Chemistry Department of the College of Agriculture. The solvent used was rain water.

METHODS

Equipment

The equipment used were a Riehlé tensile testing machine; single molds; a six-gang tension briquette mold; and sundry equipment for mixing mortar batches.

Curing

The briquettes were cured in a moist chamber for 24 hours. After 24 hours the briquettes were transferred into a vat of rain water where these were kept until tested. The briquettes were cured for 7 and 28 days.

Sets

Eleven sets of tests were run in this study. Set A had no admixture in the mixing water; B had 1.07 per cent sodium chloride admixture; C, 2.16; D, 3.24; E, 4.32; F, 5.27; G. 6.38; H, 8.04; I, 8.99; J, 10.03; and K, 11.30. Each set was divided into two, and run for 7 and 28 days curing.

Briquettes

In this study, 1:3 cement mortar (by weight) was used. After the normal consistency of the cement was found, the amount of mixing water was fixed so that each set had the same volume of solution. This amount was 410 cubic centimeters to 500 grams of cement and 1500 grams of sand.

The briquettes were made according to the methods of the American Society for Testing Materials.

RESULTS AND DISCUSSION

General observations

The briquettes were found to have a dull green color after seven days and greyish green after twenty-eight days of curing.

Crystalline scums were noticed on the surface of the curing water after the curing period of the briquettes. This is probably the calcium hydroxide reported by a number of investigators.

Tests

Table 1 shows the results as actually found. In table 2 it will be noticed that the addition of sodium chloride admixture up to 10.03 per cent in the mixing water increases the tensile strength of the cement mortar in seven days. Also, that this same admixture up to 11.30 per cent increases the tensile strength of cement mortar even after twenty-eight days.

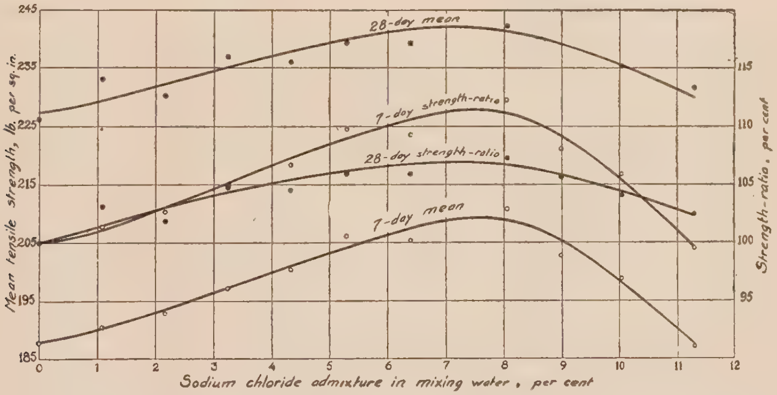

Chart 1.—Mean tensile strength and strength-ratio against per cent sodium chloride admixture.

It was found that an admixture of 8.04 per cent sodium chloride gave the best tensile strength. With this percentage of admixture, the cement mortar gave a strength-ratio of 112.3 (expressed in percentage of that of pure water mix) for 7-day old tests, and 107.3 for 28-day old tests.

Chart 1 shows the curves obtained by plotting the mean tensile strength, in pounds per square inch, and strength-rations, against per cent of sodium chloride admixture in the mixing water. The strength-ratio curves crosses at two points. This would indicate that the strength-ratios of cement mortars are the same for 7–and 28-day curing for admixtures of between 2 to 2.5 per cent, and 10 to 10.5 per cent.

SUMMARY

1. Sodium chloride admixture up to about 11 per cent increases the tensile strength of cement mortar in 7 and 28 days.

2. The maximum tensile strength is obtained with an admixture of about 8 per cent sodium chloride both at 7–and 28-day curing in water.

3. The strength-ratios of cement mortar with sodium chloride admixture at between 2 to 2.5 per cent and at 10 to 10.5 per cent are the same for 7–and 28-day curing.

4. The strength-ratios of cement mortar with sodium chloride admixture for 7-day old tests are greater than 28-day old tests with admixture of between 2 and 10 per cent.

5. The difference in strength-ratios of cement mortar with sodium chloride admixture increases in favor of 28-day old tests as the admixture per cent is raised above 10.

6. The strength-ratios obtained are all better than the acceptable strength-ratio for mixing waters.

7. The mean tensile strength of cement mortar with sodium chloride admixture in percentages greater than 8 decreases more abruptly in 7-day than in 28-day cured tests.

8. The strength increases in 7-day old cement mortars with sodium chloride admixture of from 2 to 10 per cent is decidedly due to the admixture.

9. Any amount of sodium chloride admixture up to and a little over 11.30 per cent increases the strength of cement mortar in 28 days. The increase is decidedly due to the admixture.

TABLE 1

Tensile strength in pounds per square inch of 1:3 natural sand mortars[a]

SET[b]	A	B	C	D	E	F	G	H	I	J	K
7 days	180	200	202	206	204	198	208	200	204	200	184
	186	198	198	192	198	200	208	214	206	196	192
	188	200	180	200	202	206	214	212	204	210	186
	184	204	194	190	200	180	206	224	190	194	186
	184	180	198	190	202	196	210	208	212	210	190
	178	208	198	190	186	198	208	212	202	208	186
	180	200	186	190	200	210	206	214	194	184	188
	188	198	200	182	198	194	202	212	204	200	192
	188	200	208	190	202	196	200	216	198	202	194
	188	180	180	216	198	212	202	214	200	196	186
	192	190	200	172	204	222	208	206	190	190	184
	190	180	184	214	204	222	208	202	200	202	190
	192	200	190	190	192	222	204	206	204	188	184
	190	172	198	200	190	210	204	214	212	208	182
	194	186	190	206	204	208	206	214	210	190	190
	192	180	186	204	204	218	204	208	204	200	186
	192	178	182	202	208	204	198	206	214	196	182
	196	178	194	210	206	212	198	214	208	200	190
28 days	228	232	232	230	236	220	242	238	228	230	230
	220	250	214	228	240	230	236	244	244	236	236
	230	244	234	226	250	232	236	242	236	240	228
	220	242	244	242	230	234	240	240	232	238	238
	230	232	242	240	226	238	238	242	234	234	240
	230	250	228	240	228	234	236	244	232	234	224
	228	232	230	238	234	240	244	250	238	234	230
	234	240	220	242	244	232	258	238	232	232	238
	236	220	240	240	234	228	240	244	238	240	238
	220	230	234	228	240	250	234	260	232	232	230
	232	226	232	240	230	238	228	250	240	236	232
	224	232	240	236	240	248	236	242	254	230	230
	222	242	230	228	236	252	244	238	244	240	228
	224	220	220	238	244	242	230	230	232	236	230
	226	220	230	236	236	248	236	240	252	240	232
	222	224	220	254	236	254	252	250	248	230	226
	224	228	224	252	236	252	238	238	254	244	234
	220	224	232	234	234	238	244	244	236	232	228

[a] Fresh water sand from Bay, Laguna.

[b] A, 0 per cent salt (NaCl); B, 1.07 per cent salt admixture in solution; C, 2.16; D, 3.24; E, 4.32; F, 5.27; G, 6.38; H, 8.04; I, 8.99; J, 10.03; and K, 11.30.

TABLE 2

Mean tensile strength of 1:3 natural sand mortar with salt admixture, its probable error, significance of difference, and strength-ratio

SET[a]	MEANS	PROBABLE ERRORS	RATIO OF THE DIFFERENCE OF MEANS TO PROBABLE ERROR OF THE DIFFERENCE OF MEANS[b]											STRENGTH RATIO[c]
			A	B	C	D	E	F	G	H	I	J	K	
	lbs. per sq. in.	±												*per cent*
A 7	187.833	.78601		N	S	S	S	S	S	S	S	S	N	100
28	226.167	.75961		S	S	S	S	S	S	S	S	S	S	100
B 7	190.5	1.74431	1.3		N	N	S	S	S	S	S	S	N	101.4
28	233.167	1.5288	4.1		N	N	N	S	S	S	S	N	N	103.1
C 7	192.833	1.26548	3.4	1.1		N	S	S	S	S	S	S	S	102.7
28	230.5	1.2313	3	1.4		S	S	S	S	S	S	S	N	101.9
D 7	197.167	1.71679	4.9	2.7	2		N	S	S	S	N	N	S	104.9
28	237	1.20106	7.6	2	3.4		N	N	N	S	N	N	S	104.8
E 7	200.5	.87494	10.8	5.2	5	1.7		N	S	S	N	N	S	106.7
28	236.167	.97373	8.1	1.7	3.6	.5		N	N	S	N	N	S	104.4
F 7	206.167	1.77231	9.5	6.3	6.1	3.6	2.9		N	N	N	S	S	109.8
28	239.5	1.46036	8.1	3	4.7	1.3	1.9		N	N	N	N	S	105.9
G 7	205.333	.63409	17.3	8	8.8	4.4	4.5	.4		S	N	S	S	109.3
28	239.5	1.17163	9.6	3.3	5.3	1.5	2.2	0		N	N	S	S	105.9
H 7	210.833	.86842	19.6	10.4	11.7	7.1	8.4	2.3	5.1		S	S	S	112.3
28	242.667	1.01716	13	5.2	7.6	3.6	4.6	1.8	2		N	S	S	107.3
I 7	203	1.09065	11.3	6.1	6.1	2.9	1.8	1.5	1.8	5.6		N	S	108.1
28	239.167	1.24385	8.9	3	5	1.3	1.9	.2	.2	2.2		N	S	105.7
J 7	199	1.13599	8.1	4.1	3.6	.9	1	3.4	4.9	8.3	2.5		S	105.9
28	235.5	.62121	9.5	1.4	3.6	1.1	.6	2.5	3	6	2.6		N	104.1
K 7	187.167	.55424	.7	.4	4.1	5.5	12.9	10.2	21.6	23	12.9	9.4		99.6
28	231.833	.67125	5.6	.8	.9	3.6	3.7	4.8	5.7	8.9	5.2	.4		102.5

[a] 7 denotes seven-day old set; 28, twenty-eight-day old set.

[b] S denotes significant difference in strength; N, not significant. Ratios of 3 or more are significant.

[c] Strength of test expressed in percentage of that of pure water mix.

A COMPARISON OF HYDROCHLORIC ACID AND INVERTASE HYDROLYSIS METHODS OF SUCROSE DETERMINATION IN SUGAR CANE PRODUCTS[1]

GENARO C. BERMEJO AND R. H. KING

WITH ONE CHART

INTRODUCTION

The problem

Sucrose is the most important constituent of sugar cane and its products. Since cane sugar factories are based on a sucrose basis, a study of an accurate method of determination of this constituent is of great importance in chemical control work. With such accurate information the chemist is enabled to locate and correct the source or sources of losses in the various stages of sugar manufacture, thereby increasing the recovery of the factory.

Review of literature

The hydrochloric acid inversion adopted by the Association of Hawaiian Sugar Technologists (1924) is the standard method used in Philippine sugar factories for the determination of sucrose in all sugar house products.

In the presence of much levulose, as in cane syrup and molasses, the optical method for sucrose, requiring hydrolysis by acid, gives erroneous results. (Official and Tentative Methods of Analysis of the Association of Official Agricultural Chemists, 1925). In such cases inversion by invertase is recommended by Paine and Balch (1925b) and Circular No. 44 of the Bureau of Standards, Washington (1918).

Coates and Shen (1928) state the probability of the adoption of the invertase method as the standard commercial method, but they add that at present most invert polarizations are made after acid hydrolysis.

Circular No. 44 of the Bureau of Standards, Washington (1918) states that at the meeting in 1916 of the Association of Official Agricultural Chemists a report was presented to the effect that as the amount of invert sugar increases there is also an increase in the sucrose error by acid hydrolysis. Sucrose by hydrochloric acid is lower than the true sucrose content of the sample. Upon application of the invertase method to solutions of sucrose and invert sugar more accurate results were obtained than by acid hydrolysis.

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[1] Contribution from the Sugar Technology Division, Department of Agricultural Chemistry, College of Agriculture. Experiment Station contribution No. 602.

Paine and Balch (1925b) have worked on beet molasses and raw massecuite and their results show that the sucrose by invertase method is greater than the sucrose by acid hydrolysis. Similar results were obtained by King (1928) on Hawaiian molasses.

Object of the present work

The object of the present work is to investigate the serious errors present in the determination of sucrose in sugar cane products by comparing the results obtained by hydrochloric acid and invertase methods of hydrolysis.

Place and time of the present work

The work was done in the Sugar Laboratory of the College of Agriculture, University of the Philippines, Los Baños, Laguna, from October, 1928 to January, 1929.

MATERIALS AND METHODS

Apparatus used

The apparatus used in this work were:

Cenco balance, sensitive to 0.10 gram
Chainomatic balance (quantitative)
Brix spindles, calibrated at 27.5°C.
Electric oven
Volumetric flasks, calibrated
Kohlrausch flasks, calibrated
Volumetric pipettes, calibrated
Polariscope tubes, one 200 mm. tube, side neck, and another 200 mm. tube, side neck and water jacketed
Bausch and Lomb saccharimeter, calibrated at 27.5°C.
Thermometers graduated to 0.10°C.
Glassware, etc.

Sugar cane products analyzed

In the present study the following samples of sugar cane products were analyzed: final molasses and B-massecuite, raw cane juice, panocha and centrifugal raw and refined sugars.

Final molases samples 1, 2, and 3 were obtained from Calamba Sugar Estate; samples 4, 5, and 6 from Pampanga Sugar Mills; samples 7 and 8 from Pampanga Sugar Development Co., Inc., sample 9 from Ma-ao Sugar Central, sample 10 from Victorias Milling Co.; sample 11 from Isabela Sugar Company; sample 12 from Tarlac Sugar Central; and sample 13 is a B-massecuite sample from Calamba Sugar Estate.

Sugar sample 1 was obtained from Ma-ao Sugar Central; sample 2 from San Carlos Milling Company; sample 3 from North Negros Sugar

Company; sample 4 from Isabela Sugar Company; sample 5 from Victorias Milling Company; sample 6 is refined sugar from the same factory. Sample 7 is panocha sugar.

Reagent used

Solid reagents and solutions used in the analyses were:

Solid reagents. Horne's dry lead sub-acetate, powdered anhydrous potassium dihydrogen phosphate, and zinc dust.

Solutions. Hydrochloric acid, c. p., diluted 1: 1; phosphoric acid 10 per cent; stannic chloride 10 per cent; invertase scales 1 per cent; lead subacetate 54 brix.

Preparation of samples

Every sample of final molasses and B-massecuite was thoroughly mixed before 150 grams were weighed for analysis.

Raw juice was obtained from cane grown in the College plot. Several stalks of cane were cut into five portions. Juice was expressed by the hand mill.

The sugar was thoroughly mixed before weighing a sample for moisture and for sucrose. Panocha sugar, obtained in the vicinity, was sliced, mixed thoroughly, and sampled.

Determination of factors

The determination of the Clerget factor for the particular conditions of the analysis is advised by Browne (1912) and Deerr (1921). Paine and Balch (1925a) emphasize the importance of precise evaluation of the enzyme hydrolytic constants.

a. For acid hydrolysis. Fifty-two grams of pure sucrose were dissolved in a 200-cc. Kolrausch flask. The solution was clear. No lead was added. It was diluted to the mark and filtered. The direct polarization was made in a 200-mm. tube.

For the invert reading, the method adopted by the Association of Hawaiian Sugar Technologists (1924) was followed. Fifty cubic centimeters of the clear solution were pipetted into a 100 cc. volumettric flask to which 25 cc. water were added. The flask was heated in a water bath to 65°C. It was then removed and immediately 10 cc. of a mixture of equal volumes of concentrated hydrochloric acid and water were added. The mixture was allowed to stand for 30 minutes before bringing to room temperature and making up to volume. Then it was shaken and polarized in a 200-mm. water-jacketed tube, noting the temperature at the time of observation. The average of the readings of five inversions was found and used in the calculation of the Clerget divisor. This factor was found to be 142.66 for 13 grams of sucrose.

b. For invertase hydrolysis. The filtrate from the direct reading contains no lead. To 50-cc. portions in 100-cc. volumetric flasks, 25 cc.

water, 5 cc. prepared invertase solution, and a few drops of a 10 per cent solution of phosphoric acid, to give faint acidity to methyl red, were added. This solution was placed in a water bath held at 55°C. for varying periods of time, and allowed to cool slowly to varying temperatures before cooling and making up to volume. It was found that the most complete inversion was obtained by holding the solution to be inverted in the water bath at 55°C. for one hour and letting it stand for two hours more before cooling and making up to volume. The results obtained from five experiments, after deducting the reading obtained for the optical activity of the invertase, were used in the calculation of the Clerget divisor. This factor was found be $141.17—0.5\ T+0.073m$, where m=grams sucrose per 100 cc. solution read in the polariscope.

Methods of analysis

a. Solids. To a sample of 150 grams of molasses in a copper bucket, 750 grams of water were added. The molasses was dissolved by hand and the solution was mixed thoroughly by pouring back and forth from one container into another. A sugar cylinder was filled with the solution and a Brix spindle was slowly lowered into it. After standing for a few minutes the observed Brix and temperature were noted. Temperature corrections were taken from table 2 of the Methods of Chemical Control for Cane Sugar Factories (1924). The corrected Brix multiplied by 6 gave the gravity solids in the undiluted sample. The solids in massecuite were determined in the same way.

Gravity solids in raw juice were determined as above except that it was not diluted.

Solids in sugar were determined by difference; that is, 100—per cent moisture. Duplicate samples of from 3 to 5 grams of the thoroughly mixed sugar were weighed into tared aluminum dishes with covers. These were placed in an electric oven kept at 100°—105°C. for three hours, after which time they were weighed again. The loss in weight, divided by the weight of the sample and multiplied by 100, gave the percentage of moisture.

b. Sucrose. Two methods were used in the determination of sucrose. The first was the standard hydrochloric acid method adopted by the Association of Hawaiian Sugar Technologists (1924). It consists of the following procedure in the case of molasses and massecuite: To about 600 cc. of the diluted solution from the Brix determination 30 grams of Horne's dry lead sub-acetate powder were added. The mixture was well shaken and filtered.

Seventy-five cubic centimeters of the clear filtrate were pipetted into a 100-cc. volumetric flask. Ten cubic centimeters of a 10 per cent solution of phosphoric acid were added. The solution was made up to volume, and about one-half gram of zinc dust was added and the solution was allowed to decolorize for 30 minutes. Then it was filtered and the direct reading was obtained in a 200-mm. tube.

Another 75-cc. portion of the clear filtrate was pipetted into a 100 cc. volumetric flask, and 2 cc. of 1: 1 hydrochloric acid were added. A thermometer was inserted and the flask was heated in a water bath to 65°C. The flask was removed from the bath and 10 cc. of 1: 1 hydrochloric acid were added. Inversion was allowed to proceed for 30 minutes standing at room temperature. Then the thermometer was rinsed with water, and the solution made up to volume. About one-half gram of zinc dust was added and the solution was allowed to decolorize for 30 minutes. Then it was filtered and the invert reading was obtained in a 200 mm. water jacketed tube. The temperature of the invert solution was noted carefully at the time of polarization.

The reading for approximate sucrose was calculated by the following formula:

$$\text{Reading for approximate sucrose} = \frac{100\ (D-I)}{142.0-0.5T}$$

where D and I are the direct and invert readings respectively and T is the temperature.

The uncorrected Brix of the diluted molasses was used to determine the factor given in table 9, column 3 or 6. The reading for approximate sucrose given by the above formula multiplied by this factor gives the approximate sucrose which was then used to determine the correctly interpolated factor which can be obtained from table 10.

The sample of raw juice, as expressed by the hand mill, was mixed thoroughly and a convenient amount was clarified by Horne's dry lead subacetate and filtered. Seventy-five cubic centimeters of the clear filtrate were pipetted into a 100-cc. volumetric flask, and made up to volume. The direct reading was made in a 200-mm. tube.

Another 75-cc. portion was pipetted into a 100-cc. volumeteric flask. One cubic centimeter of 1: 1 hydrochloric acid was added and the solution was inverted as in molasses. The approximate sucrose was obtained from the Methods of Chemical Control for Cane Sugar Factories (1924) and the correctly interpolated factor was used in the calculation.

Fifty-two grams of the sugar sample were dissolved in a 200 cc. Kolrausch flask. When clarification was necessary 1 to 2 cc. of 54 Brix lead sub-acetate solution was added. The solution was made up to volume and filtered.

Direct reading was made from the clear filtrate. Fifty cubic centimeters were pipetted and inverted as in the above procedure. Sucrose was calculated from the formula:

$$Sucrose = \frac{100\ (D-2\ I)}{142.66-0.5T}$$

The other method was the invertase hydrolysis method. It consists of the following procedure: The clear filtrate from the lead clarification in the above procedure was deleaded completely with powdered anhydrous potassium dihydrogen phosphate, and filtered.

Direct readings were made as in the other procedures.

Seventy-five cubic centimeters of the deleaded filtrate of molasses and raw juice, 50 cc. in the case of sugar, to which 25 cc. water were added, were pipetted into a 100 cc. volumetric flask. A few drops of a 10 per cent solution of phosphoric acid were added to give slight acidity to methyl red. Then 5 cc. of 1 per cent solution of invertase solution were added. Inversion was made in a water bath at 50°—55°C. The flask was held in the bath at this temperature, and shaken frequently for a period of one hour. It was then removed and allowed to stand for two hours at room temperature. Ten cubic centimeters of a 10 per cent solution of phosphoric acid were added, and the solution was cooled and made up to volume. Dark colored solutions were decolorized by zinc dust. Invert readings were made and the temperatures at the time of observation were noted carefully. All the invert readings were corrected for the optical activity of the invertase added.

Sucrose in molasses was calculated from the formula:

$$Sucrose = \frac{100\ (D - I)}{F - 0.5\ T} X\ factor$$

where $F = 141.17 + 0.073\ m$, and m = gram sucrose per 100 cc. The same factor obtained from table 9 is used as in the calculation of sucrose in molasses by hydrochloric acid inversion.

Invertase hydrolysis factors for different sucrose concentrations are given in table II.

$$Sucrose\ reading\ in\ juice = \frac{100\ (4/3\ D - 4/3\ I)}{F - 0.5\ T}$$

The percentage of sucrose was then taken from the corresponding uncorrected Brix in table 4 of the Methods of Chemical Control for Cane Sugar Factories (1924).

$$Sucrose\ in\ sugar = \frac{100\ (D - 2\ I)}{142.12 - 0.5\ T}$$

RESULTS

Table 1 shows the results of the analyses of some Philippine final molasses and B-massecuite samples by hydrochloric acid and invertase methods of hydrolysis. The difference in sucrose and gravity purity of the samples by the two methods are given in table 2.

King (1928) analyzed Hawaiian final molasses by hydrochloric acid and invertase methods, and the results of his work are reproduced in table 3. Table 4 shows the difference in sucrose and gravity purity of the Hawaiian molasses samples by the two methods. Note that some of the differences are negative. Minus signs (—) show that the result obtained by acid hydrolysis is greater than that by invertase hydrolysis.

The analyses of the juice are given in table 5. Table 6 shows the difference in sucrose and gravity purity by the two methods.

DISCUSSION OF RESULTS

In table 1 sucrose in molasses and massecuite was calculated first with the factor constant, and then with the factor interpolated. The results obtained by using the constant factor were not more than 0.03 per cent in molasses when the interpolated factor was used. The values obtained by using the interpolated factor were used in comparing with values obtained by the invertase method, as shown in table 2. Sucrose by invertase method is greater than sucrose by hydrochloric acid method. The difference varies from a minimum of 0.01 per cent to a maximum of 0.54 per cent. Gravity purity is dependent upon sucrose, hence, it follows that gravity purity by invertase method is greater than that by hydrochloric acid method. The difference varies from 0.01 per cent to 0.59 per cent. This indicates that an error of 1.54 per cent in the determination of gravity purity can be expected. The error is due to the presence of a large amount of reducing sugars.

Referring again to table 1, it may be seen that sucrose by invertase is greater than the polarization, the difference ranges from 1.56 to 6.55 per cent. This clearly indicates that the use of apparent purity or polarization figure in low grade products is not to be recommended in the chemical control of the sugar factory.

The analyses of Hawaiian final molasses for the 1927-28 season are shown in table 3. This work in Hawaii substantiates the work on Philippine molasses although the difference was much larger in Hawaii than in the Philippines. From table 4 it may be seen that the sucrose varies from —0.67 to 1.17 per cent, and the gravity purity from—0.77 to 1.47 per cent. It appears that the molasses produced in the Hawaiian Islands contains substances which affect the invert reading which consequently makes the sucrose figure by hydrochloric acid method lower than the true sucrose. It appears also that some molasses contains substances affected in an opposite way by acid and as a result high sucrose by the standard method is obtained.

From table 5 the difference between gravity purity by hydrochloric acid method and apparent purity varies from 1.04 per cent at the upper botton of the cane stalk to 2.95 per cent at the top portion. The presence of reducing sugars in the top portion of the stalk accounts for this error. Table 6 shows that the difference in sucrose by two methods is from zero to 0.07 per cent. The error in gravity purity of the top portion jumps to 0.49 per cent, owing to low Brix solids. The middle portion of the stalk does not show any difference by the two methods of analysis.

There appears to be but very little error in the analysis of some Philippine raw and refined sugars by hydrochloric acid inversion, as shown in tables 7 and 8. The difference in sucrose and gravity purity between these two methods varies only in the second decimal place from—0.02 per cent to 0.02 per cent. In panocha sugar the molasses was not removed. The difference in sucrose as found is 0.48 per cent.

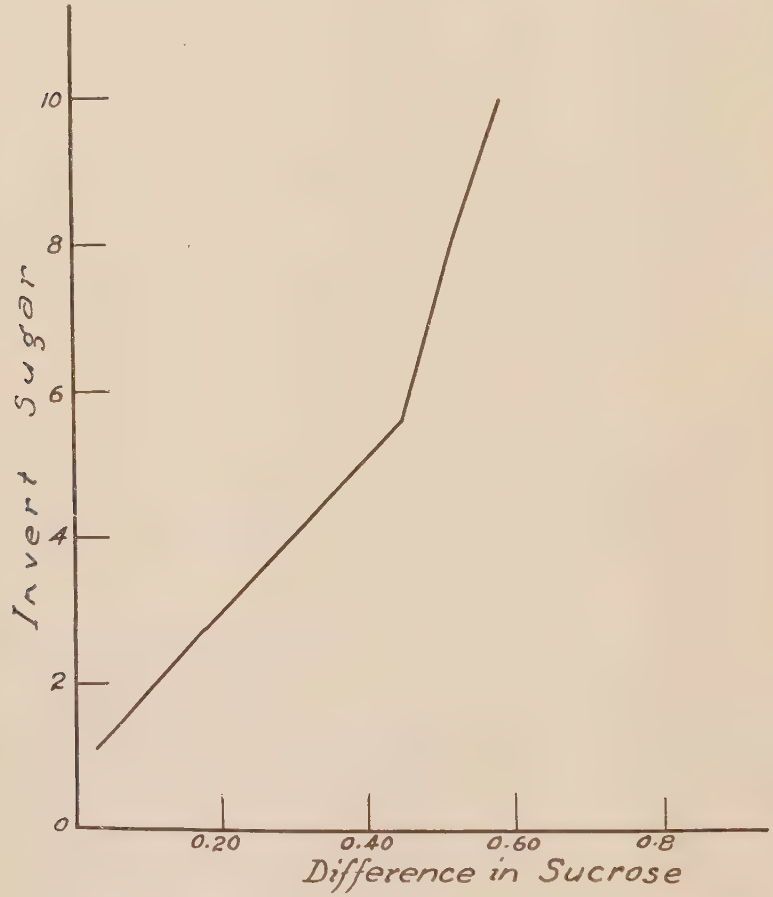

Chart 1.—Sucrose error by HCl inversion in the presence of invert sugar.

These results indicate that little error is introduced in chemical control by the use of acid hydrolysis in the analysis of mixed juice and other cane products of more or less equal purity as clarified juice and syrup. The determination of sucrose in commercial sugar by hydrochloric acid inversion is very satisfactory. However, the considerable error in the analysis of low grade cane products, such as final molasses, A-molasses and B-massecuite, indicates that where accurate determination of sucrose is desired, the invertase method of hydrolysis should be used in preference to the hydrochloric acid method.

Haddon (1928) found that the presence of dextrin in some Uba Molasses gave erroneous results. He recommends the use of ammoniacal lead acetate or stannic chloride solution as the precipitating agent of dextrin, which substance must be removed before polarization. Stannic chloride was used in the present work but was of no aid in the correction of the erroi he observed.

The data plotted in chart 1 were obtained from Circular No. 44 of the Bureau of Standards, Washington (1918). This graph shows the error introduced into a determination of sucrose by the hydrochloric acid method by increasing weights in grams of invert sugar per 100 cc. of solution. This information indicates that the invert sugar is the source of the largest error in sucrose determinations by this method.

SUMMARY

1. Two methods of sucrose determination were employed in the present work, namely, by hydrochloric acid and by invertase hydrolysis.
2. Samples of molasses, massecuite, raw juice, and sugar were analyzed for solids and sucrose.
3. Sucrose by invertase hydrolysis is greater than sucrose by acid hydrolysis in the case of Philippine molasses and massecuite. The difference varies from 0.01 to 0.54.
4. In juices the difference in sucrose is appreciable when the purity is low.
5. Close results were obtained by two methods in the analyses of centrifugal raw and refined sugars. Hydrochloric acid inversion is satisfactory in this analysis.
6. For the determination of sucrose in low grade sugar house products the invertase methods is to be preferred. The errors due to the presence of invert sugar are eliminated.

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TABLE 1

Analyses of Philippine final molasses by two methods

							HYDROCHLORIC ACID METHOD							INVERTASE HYDROLYSIS METHOD			
SAMPLE	OBS. BRIX	TEMP.	COR. BRIX	COR. BRIX ×6	DIRECT READ.	POLN.	APP. PTY.	INVERT READ.	TEMP.	SUC. 142.0	GR. PTY.	SUC. INTP.	GR. PTY.	INVERT READ. +0.10	TEMP.	SUCROSE	GR. PTY.
		°C.							°C.						°C.		
1	14.90	27.0	14.86	89.16	14.60	28.80	32.30	6.10	28.2	31.89	35.77	31.88	35.76	6.20	28.2	32.33	36.27
2	14.70	25.0	14.52	87.12	15.00	29.58	33.95	7.10	26.4	33.84	38.83	33.82	38.82	7.10	26.2	34.10	39.14
3	14.90	22.0	14.54	87.24	16.40	32.40	37.14	7.84	25.2	36.92	42.32	36.89	42.28	7.90	24.8	37.24	42.69
4	13.70	27.5	13.70	82.20	17.36	34.38	41.82	6.46	29.4	37.05	45.07	37.02	45.04	6.52	29.4	37.44	45.55
5	15.30	26.0	15.11	91.14	13.30	26.16	28.70	7.32	29.6	31.89	34.99	31.88	34.98	7.48	29.0	32.35	35.50
6	15.30	24.0	15.06	90.36	15.42	30.42	33.67	8.10	27.0	36.01	39.85	35.98	39.82	8.15	27.0	36.38	40.26
7	14.50	27.0	14.46	86.76	14.00	27.66	31.88	6.80	29.0	32.20	37.11	32.18	37.09	6.90	28.8	32.62	37.59
8	14.70	23.0	14.40	86.40	14.55	28.74	33.26	7.05	25.0	32.90	38.08	32.88	38.05	7.15	25.0	33.33	38.58
9	13.60	26.0	13.49	80.94	13.30	26.34	32.54	6.35	29.2	30.55	37.74	30.54	37.73	6.48	29.0	31.02	38.32
10	15.00	28.0	15.04	90.24	12.50	24.66	27.33	7.00	29.2	30.15	33.41	30.14	33.40	7.20	28.6	30.67	33.99
11	14.70	24.0	14.36	86.16	17.00	33.60	39.00	6.10	25.0	35.18	40.83	35.15	40.80	5.90	25.0	35.16	40.81
12	15.40	26.0	15.19	91.14	13.40	26.46	29.03	8.00	25.0	32.50	35.66	32.48	35.64	8.15	25.0	33.01	36.22
13	16.20	25.0	16.02	96.12	28.95	56.82	59.11	10.48	25.0	59.69	62.09	59.54	61.95	10.50	25.0	59.99	62.45

TABLE 2

Difference in sucrose and gravity purity of Philippine final molasses as shown by two methods of analysis

	SUCROSE			GR. PTY.		
SAMPLE	HCl METHOD	INVERT HYD. METHOD	DIFF.	HCl METHOD	INVERT HYD. METHOD	DIFF.
1	31.88	32.33	0.45	35.76	36.27	0.51
2	33.82	34.10	0.28	38.82	39.14	0.32
3	36.89	37.24	0.35	42.28	42.69	0.41
4	37.02	37.44	0.42	45.04	45.55	0.51
5	31.88	32.35	0.47	34.98	35.50	0.52
6	35.98	36.38	0.40	39.82	40.26	0.44
7	32.18	32.62	0.44	37.09	37.59	0.50
8	32.88	33.33	0.45	38.05	35.58	0.53
9	30.54	31.02	0.48	37.73	38.32	0.59
10	31.68	32.22	0.54	35.11	35.70	0.59
11	35.15	35.16	0.01	40.80	40.81	0.01
12	32.48	33.01	0.53	35.64	36.22	0.58
13	59.54	59.99	0.45	61.95	62.45	0.50

TABLE 3

Analyses of Hawaiian final molasses by two methods

						HYDROCHLORIC ACID METHOD						INVERTASE HYDROLYSIS METHOD			
SAMPLE	COR. BRIX	COR. BRIX × 6	DIRECT READ.	POLN.	APP. PTY.	INVERT READ.	TEMP.	SUC. 142.0	GR. PTY.	SUC. INTP.	GR. PTY.	INVERT READ. × 0.15	TEMP.	SUC.	GR. PTY.
							°C.						°C.		
1	15.42	92.52	22.95	45.12	48.77	9.25	27.1	49.26	53.24	49.18	53.16	8.85	26.8	48.96	52.92
2	14.57	87.42	13.65	26.94	30.82	7.23	27.1	32.06	36.67	32.04	36.65	6.57	26.8	31.37	35.88
3	14.91	89.46	13.68	26.88	30.05	7.38	27.1	32.30	36.11	32.28	36.08	6.92	26.8	31.91	35.67
4	15.39	92.34	14.57	28.62	30.99	8.27	27.1	34.96	37.86	34.93	37.83	8.07	26.8	34.97	37.87
5	14.89	89.34	12.36	24.36	27.27	8.35	27.2	31.77	35.56	31.75	35.54	8.20	26.9	31.86	35.66
6	13.64	81.84	12.01	23.76	29.03	7.70	27.2	30.38	37.12	30.37	37.11	7.57	26.9	30.51	37.28
7	14.49	86.94	14.00	27.66	31.82	6.86	27.1	32.04	36.85	32.02	36.83	6.72	27.0	32.17	37.00
8	15.01	90.06	15.15	29.82	33.11	8.43	27.1	36.18	40.17	36.12	40.10	8.50	26.6	36.55	40.58
9	14.39	86.34	16.89	31.38	36.34	7.48	26.9	37.42	43.34	37.39	43.30	7.85	26.8	38.34	44.41
10	14.71	88.26	13.11	25.86	29.30	9.25	26.8	34.28	38.84	34.26	38.82	9.15	26.9	34.50	39.09
11	15.09	90.54	13.77	27.18	30.02	8.00	26.8	33.32	36.80	33.30	36.78	7.85	26.9	33.47	36.97
12	14.69	88.14	13.66	26.94	30.57	8.17	26.1	33.38	37.87	33.36	37.84	7.76	26.7	33.19	37.66
13	14.27	85.62	12.44	24.60	28.73	9.65	24.2	33.55	39.18	33.53	39.16	9.85	24.2	34.22	39.97
14	15.45	92.70	16.45	32.28	34.82	7.23	24.9	35.89	38.72	35.86	38.69	7.95	24.1	37.23	40.16
15	14.33	85.98	15.47	30.48	35.45	6.16	25.0	33.00	38.38	32.97	38.35	6.77	24.3	34.20	39.78
16	14.72	88.32	14.67	29.04	32.88	7.17	25.0	33.22	37.61	33.20	37.57	7.65	24.6	34.26	38.79
17	15.14	90.84	11.17	22.02	24.24	9.37	24.6	31.13	34.27	31.12	34.26	9.65	24.5	31.90	35.11
18	15.34	92.04	16.37	32.16	34.94	7.87	25.0	36.77	39.95	36.74	39.91	8.35	24.2	37.74	41.00
19	13.77	82.62	12.21	24.24	29.34	7.75	24.8	30.45	36.86	30.44	36.84	8.30	24.5	31.61	38.26
20	14.86	89.16	15.57	30.72	34.45	7.26	24.8	34.67	38.88	34.64	38.85	7.35	24.5	35.13	39.40
21	15.66	93.96	15.27	30.00	31.93	6.85	24.8	33.49	35.64	33.46	35.61	7.05	24.7	34.14	36.33

TABLE 4

Difference in sucrose and gravity purity of Hawaiian final molasses as shown by two methods of analysis

SAMPLE	SUCROSE			GR. PTY.		
	HCl METHOD	INVERT HYD. METHOD	DIFF.	HCl METHOD	INVERT HYD. METHOD	DIFF.
1	49.18	48.96	–0.22	53.16	52.92	–0.24
2	32.04	31.37	–0.67	36.65	35.88	–0.77
3	32.28	31.91	–0.37	36.08	35.67	–0.41
4	34.93	34.97	0.04	37.83	37.87	0.04
5	31.75	31.86	0.11	35.54	35.66	0.12
6	30.37	30.51	0.14	37.11	37.28	0.17
7	32.02	32.17	0.15	36.83	37.00	0.17
8	36.12	36.55	0.43	40.10	40.58	0.48
9	37.39	38.34	0.95	43.30	44.41	1.11
10	34.26	34.50	0.24	38.82	39.09	0.27
11	33.30	33.47	0.17	36.78	36.97	0.19
12	33.36	33.19	–0.17	37.84	37.66	–0.18
13	33.53	34.22	0.69	39.16	39.97	0.81
14	35.86	37.23	1.17	38.69	40.16	1.47
15	32.97	34.20	1.13	38.35	39.78	1.43
16	33.20	34.26	1.06	37.59	38.79	1.20
17	31.12	31.90	0.78	34.26	35.11	0.85
18	36.74	37.74	1.00	39.91	41.00	1.09
19	30.44	31.61	1.17	36.84	38.26	1.42
20	34.64	35.13	0.49	38.85	39.40	0.55
21	33.46	34.14	0.68	35.61	36.33	0.72

TABLE 5

Analyses of cane juice by two methods

							HYDROCHLORIC ACID METHOD				INVERTASE HYDROLYSIS METHOD			
PORTION OF STALK	BRIX	TEMP.	COR. BRIX.	DIRECT READ.	POLN.	APP. PTY.	INVERT READ.	TEMP.	SUC.	GR. PTY.	INVERT READ. +0.10	TEMP.	SUC.	GR. PTY.
		°C.						°C.				°C.		
Bottom	19.10	26.0	18.99	53.10	17.06	89.84	16.15	27.2	17.32	91.21	15.85	27.0	17.35	91.36
Lower bottom	18.35	26.0	18.24	50.70	16.45	90.19	15.50	27.4	16.64	91.23	15.20	27.2	16.66	91.34
Middle	17.90	26.0	17.79	47.50	15.40	86.57	14.60	27.6	15.64	78.91	14.35	27.2	15.64	87.91
Upper top	17.30	26.0	17.19	44.00	14.54	83.42	13.65	27.6	14.58	84.82	13.55	27.2	14.63	85.11
Top	14.35	26.0	14.24	30.00	9.89	69.45	10.20	27.6	10.31	72.40	10.25	27.2	10.38	78.29

TABLE 6

Difference in sucrose and gravity purity of cane juice as shown by two methods of analysis

PORTION OF STALK	SUCROSE			GR. PTY.		
	HCl METHOD	INVERT HYD. METHOD	DIFF.	HCl METHOD	INVERT HYD. METHOD	DIFF.
Bottom	17.32	17.35	0.04	91.21	91.36	0.15
Lower bottom	16.64	16.65	0.02	91.23	91.34	0.11
Middle	15.64	15.64	0.0	87.91	87.91	0.0
Upper top	14.58	14.63	0.05	84.82	85.11	0.29
Top	10.31	10.38	0.07	72.40	72.89	0.49

TABLE 7

Analyses of Philippine sugar by two methods

SAMPLE					HYDROCHLORIC ACID METHOD				INVERTASE HYDROLYSIS METHOD			
	MOIST.	SOLID	POLN.	APP. PTY.	INVERT READ.	TEMP.	SUC.	GR. PTY.	*INVERT READ. 0.10	TEMP.	SUC.	GR. PTY.
						°C.				°C.		
1	0.82	99.18	97.10	97.90	14.20	28.0	97.54	98.35	13.85	28.0	97.56	98.37
2	0.34	99.66	98.15	98.48	14.30	28.0	98.52	98.86	13.95	28.0	98.54	98.88
3	0.94	99.06	96.80	97.72	14.00	28.6	97.23	98.15	13.55	29.0	97.24	98.16
4	0.96	99.04	97.30	98.24	14.06	28.6	97.71	98.65	13.60	29.0	97.71	98.65
5	0.83	99.17	97.25	98.06	14.10	28.6	97.73	98.55	13.67	28.8	97.71	98.53
6	0.28	99.72	99.50	99.78	14.12	28.6	99.52	99.80	13.70	28.8	99.51	99.79
7			81.10		12.70	26.6	82.33		12.65	26.8	82.81	

TABLE 8

Difference in sucrose and gravity purity of Philippine sugar as shown by two methods of analysis

SAMPLE	SUCROSE			GR. PTY.		
	HCl METHOD	INVERT HYD. METHOD	DIFF.	HCl METHOD	INVERT HYD. METHOD	DIFF.
1	97.54	97.56	0.02	98.35	98.37	0.02
2	98.52	97.54	0.02	98.86	98.88	0.02
3	97.23	97.24	0.01	98.15	98.16	0.01
4	97.71	97.71	0.00	98.65	98.65	0.00
5	97.73	97.71	–0.02	98.55	98.53	–0.02
6	99.52	97.51	–0.01	99.80	99.79	–0.01
7	82.33	82.81	0.48			

TABLE 9

$$\text{Sucrose in molasses} = \frac{100\ (D-I)}{142.0\ \ 0.5\,T} \times \text{Factor} \times 6$$

BRIX	FACTOR[a]	FACTOR × 6	BRIX	FACTOR[a]	FACTOR × 6
12.5	0.33161	1.98966	14.5	0.32897	1.97382
6	.33148	1.98888	6	.32884	1.97304
7	.33136	1.98816	7	.32871	1.97226
8	.33123	1.98738	8	.32859	1.97154
9	.33109	1.98654	9	.32845	1.97070
13.0	0.33096	1.98576	15.0	0.32832	1.96992
1	.33083	1.98498	1	.32819	1.96914
2	.33069	1.98414	2	.32805	1.96830
3	.33056	1.98336	3	.32792	1.96752
4	.33043	1.98258	4	.32779	1.96674
5	0.33029	1.98174	5	0.32765	1.96950
6	.33016	1.98096	6	.32752	1.96512
7	.33003	1.98018	7	.32739	1.96434
8	.32989	1.97934	8	.32727	1.96362
9	.32976	1.97856	9	.32713	1.96278
14.0	0.32963	1.97778	16.0	0.32700	1.96200
1	.32949	1.97694	1	.32687	1.96122
2	.32937	1.97622	2	.32673	1.96038
3	.32924	1.97544	3	.32660	1.95960
4	.32911	1.97466	4	.32647	1.95882
			5	.32633	1.95798

If the dilution is other than 1 in 6 use the factor and multiply by the dilution.

[a] $$\text{Factor} = \frac{26 \times 1.33333}{\text{Sp. gr.} \times 99.538}.$$

TABLE 10

Interpolated Herzfeld's factors for different sucrose concentrations
(3.0 – 14.0 grams sucrose in 100 cc.)

GRAMS IN 100 CC.	FACTOR	GRAMS IN 100 CC.	FACTOR	GRAMS IN 100 CC.	FACTOR	GRAMS IN 100 CC.	FACTOR	GRAMS IN 100 CC.	FACTOR	GRAMS IN 100 CC.	FACTOR
3.0	141.98	5.0	142.12	7.0	142.25	9.0	142.39	11.0	142.52	13.0	142.66
1	141.99	1	142.13	1	142.26	1	142.40	1	142.53	1	142.67
2	141.99	2	142.13	2	142.26	2	142.40	2	142.53	2	142.67
3	142.00	3	142.14	3	142.27	3	142.41	3	142.54	3	142.68
4	142.01	4	142.14	4	142.28	4	142.42	4	142.55	4	142.69
5	142.02	5	142.15	5	142.29	5	142.43	5	142.56	5	142.70
6	142.02	6	142.16	6	142.29	6	142.43	6	142.56	6	142.70
7	142.03	7	142.16	7	142.30	7	142.44	7	142.57	7	142.71
8	142.04	8	142.17	8	142.31	8	142.31	8	142.45	8	142.72
9	142.04	9	142.17	9	142.31	9	142.45	9	142.58	9	142.72
4.0	142.05	6.0	142.18	8.0	142.32	10.0	142.46	12.0	142.59	14.0	142.73
1	142.06	1	142.19	1	142.33	1	142.47	1	142.60	1	142.74
2	142.60	2	142.19	2	142.33	2	142.47	2	142.60	2	142.74
3	142.07	3	142.20	3	142.34	3	142.48	3	142.61	3	142.75
4	142.08	4	142.21	4	142.35	4	142.48	4	142.62	4	142.75
5	142.09	5	142.22	5	142.36	5	142.49	5	142.63	5	142.76
6	142.09	6	142.22	6	142.36	6	142.50	6	142.63	6	142.77
7	142.10	7	142.23	7	142.37	7	142.50	7	142.64	7	142.77
8	142.11	8	142.24	8	142.38	8	142.51	8	142.65	8	142.78
9	142.11	9	142.24	9	142.38	9	142.51	9	142.65	9	142.78

TABLE 11

Invertase hydrolysis factors for different sucrose concentrations (3.0 – 15.0 grams sucrose in 100 cc.)

m	FACTOR [a]	m	FACTOR [a]	m	FACTOR [a]	m	FACTOR [a]	m	FACTOR [a]	m	FACTOR [a]
3.0	141.39	5.0	141.54	7.0	141.68	9.0	141.83	11.0	141.97	13.0	142.12
1	141.40	1	141.54	1	141.69	1	141.83	1	141.98	1	142.13
2	141.40	2	141.55	2	141.70	2	141.84	2	141.98	2	141.13
3	141.41	3	141.56	3	141.70	3	141.85	3	141.99	3	142.14
4	141.42	4	141.56	4	141.71	4	141.86	4	142.00	4	142.15
5	141.43	5	141.57	5	141.72	5	141.86	5	142.01	5	142.16
6	141.44	6	141.58	6	141.72	6	141.87	6	142.02	6	142.16
7	141.44	7	141.69	7	141.73	7	141.88	7	142.02	7	142.17
8	141.45	8	141.59	8	141.74	8	141.89	8	142.03	8	142.18
9	141.45	9	141.60	9	141.75	9	141.89	9	142.04	9	142.19
4.0	141.46	6.0	141.61	8.0	141.75	10.0	141.90	12.0	142.05	14.0	142.19
1	141.47	1	141.62	1	141.76	1	141.91	1	142.05	1	142.20
2	141.48	2	141.62	2	141.77	2	141.91	2	142.06	2	142.21
3	141.48	3	141.63	3	141.78	3	141.92	3	142.07	3	142.21
4	141.49	4	141.64	4	141.78	4	141.93	4	142.08	4	142.22
5	141.50	5	141.64	5	141.79	5	141.94	5	142.08	5	142.23
6	141.51	6	141.65	6	141.80	6	141.94	6	142.09	6	142.24
7	141.51	7	141.66	7	141.81	7	141.95	7	142.10	7	142.24
8	141.52	8	141.67	8	141.81	8	141.96	8	142.10	8	142.25
9	141.53	9	141.67	9	141.82	9	141.97	9	142.11	9	142.26
										15.0	142.27

[a] Factor $= 131.17 + 10 + 0.073\, m$, where $m =$ grams sucrose per 100 cc.

COMPARATIVE NUTRITIVE VALUES OF WATER OBTAINED FROM DIFFERENT SOURCES, WITH A DETERMINATION OF THE NUTRITIVE DEFICIENCIES OF MOLAWIN CREEK WATER FOR YOUNG RICE PLANTS[1]

SERVILLANO G. GUTIERREZ

WITH EIGHT TEXT FIGURES

INTRODUCTION

It is common knowledge that plants need water for growth and existence and that water (even distilled water) usually contains in solution substances or salts, which may be beneficial but are sometimes harmful to plants. In the present study an attempt was made to determine the comparative nutritive values of water from various sources. Water was collected from a creek, from an ordinary open well, from a lake, and from other places. The water from these sources is often used for watering garden plants and plants grown in pots, and for irrigating field crops. What is supplied the plants in addition to the water itself is not definitely known. The salts and other substances that it usually contains are undoubtedly not sufficient to meet the needs of the plant. How much this deficiency is remains to be determined. The results, however, from the present study show that the water from the different sources considered had different nutritive values.

Toxic properties are possessed by water from at least one of these sources. A class in plant nutrition in the College of Agriculture repeatedly failed to grow young rice plants in culture media containing all the essential elements obtainable from the soil when the solvent was rain water collected from a roof that had been painted with Sherwin-Williams' "Red Kromik" paint. On the other hand, distilled water or ordinary tap water when substituted for this solvent, resulted in culture media which were able to produce well developed young rice plants—indicating that something toxic to the plant was present in the original culture solution.

Review of literature

No literature that has direct bearing on the subject is available. A few of the reports on the studies of the salt requirements of the young rice plants may here be cited.

Espino (1920) tried to grow young rice plants in culture solutions containing mono-potassium phosphate, calcium nitrate, and magnesium sulfate in various proportions and concentrations and found that young plants were stunted in growth and cholorotic in appearance. However, when ammonium sulfate was added to the culture solution, normal development of the young rice plants was obtained, indicating that ammonium sulfate was beneficial. The best culture solution was found to contain 1 ½ parts of $(NH_4)_2SO_4$, 1 ½ parts of Ca $(NO_3)_2$, 1 part of KH_2PO_4, and 4 parts of $MgSO_4$ with total concentration of 0.002 gram-molecule (of all the salts taken together) per liter.

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[1] Thesis presented for graduation, 1929, from the College of Agriculture No. 290; Experiment Station contribution No. 603. Prepared in the Department of Plant Physiology under the direction of Dr. Rafael B. Espino.

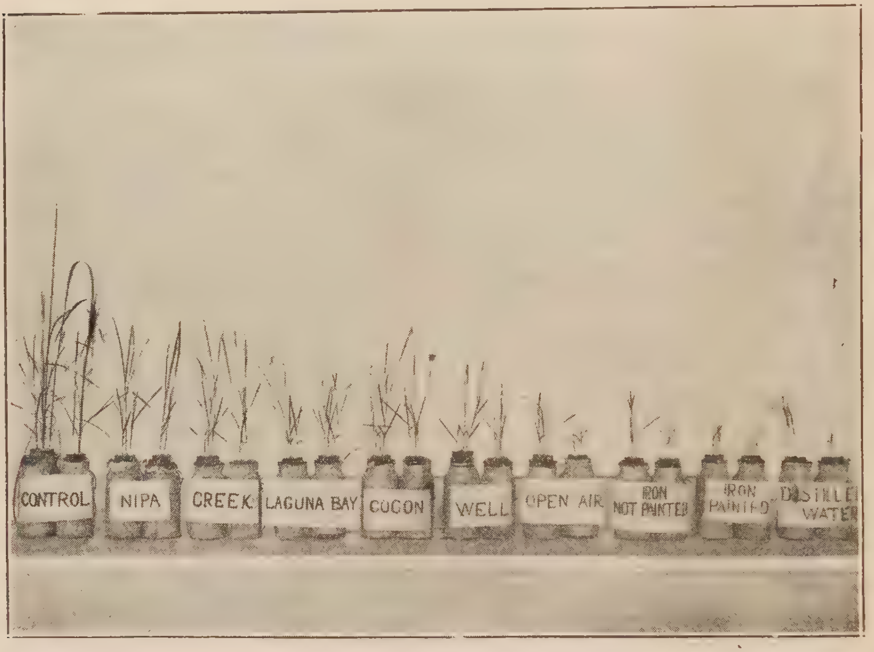

Fig. 1.—Young rice plants, var. Roxas, grown for thirty days in water from various sources. Control: Espino's 4-salt solution, type A.

Kelley (1911) found that the nitrate exerted no influence on the development of the young rice plant. It was only during the heading time that the nitrate was found to exert a stimulating effect. Kelley found also that when nitrate was the only source of nitrogen, the young rice plants were stunted in growth, and the extent of damage increased as the amount of the nitrate employed was increased.

Macasaet (1927, unpublished) found, as was expected, that the young rice plants grown in single salt solutions were abnormally developed and that nitrates, phosphates, chlorides, or carbonates at a concentration of 0.002 or 0.004 grammolecule per liter gave the young rice plants stunted growth and chlorotic appearance. Sulfates, as $(NH_4)_2SO_4$, produced fairly well developed plants but with dark green leaves.

Object of the present study

The objects of this study were, (a) to determine the relative nutritive values for young rice plants of water obtained from different sources; and (b) to determine in what way the water from the Molawin Creek is nutritively deficient for young rice plants.

Time and place

The study was conducted in the laboratory of Plant Physiology, College of Agriculture, University of the Philippines, Los Baños. It was begun in 1926 and closed in May, 1928.

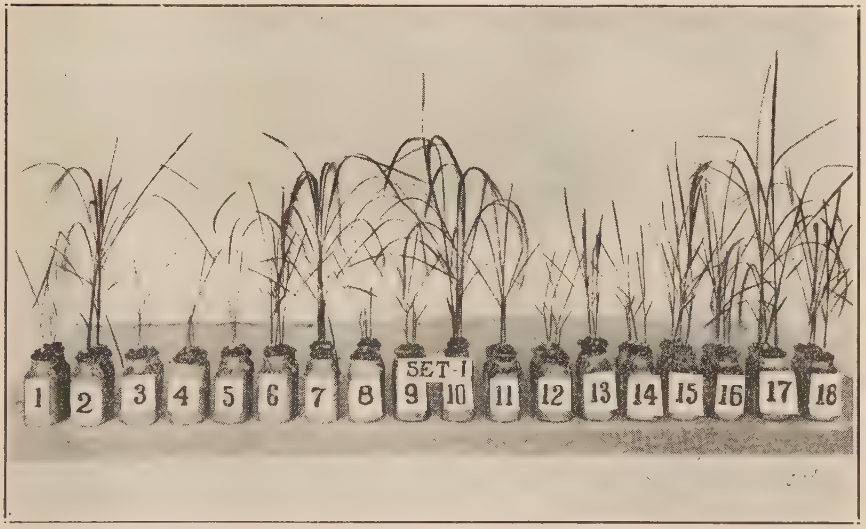

Fig. 2.—Young rice plants, var. Barao, grown for thirty days, from March 10 to April 9, 1928, in complete culture solutions in Molawin Creek water as solvent; total concentration 0.001 gram-molecule (of all salts taken together) per liter. (See table 2).

MATERIALS AND METHODS

Water from different sources

a. Rain water caught from nipa roof. Rain water was collected from the old nipa roof of a house by means of large glass funnels each fitted into the mouth of a clean demijohn. This water was slightly yellowish in color and contained small disintegrating pieces of nipa leaves. These solid bodies were removed by decantation and the water was stored in a carboy and soon after used in this study.

b. Rain water caught from cogon roof. In a manner similar to that used in collecting rain water from a nipa roof, rain water was collected from a rather old cogon roof. This water contained small pieces of the cogon leaves which were carefully removed by decantation. The water was fairly clear, but slightly pink. It was stored in a carboy and soon after was used in this study.

c. Rain water caught directly from the atmosphere. Several large glass funnels each fitted into the mouth of a one-liter bottle were used in catching rain water directly as it fell. This water was as clear as distilled water; it was stored in a clean carboy.

d. Rain water caught from unpainted galvanized iron roof. Rain falling on the unpainted galvanized iron roof of a house ran downward through a drainage pipe and was caught in a large glass funnel into a demijohn. The water was almost as clear as the rainwater caught directly; it was stored in a carboy suitably stoppered.

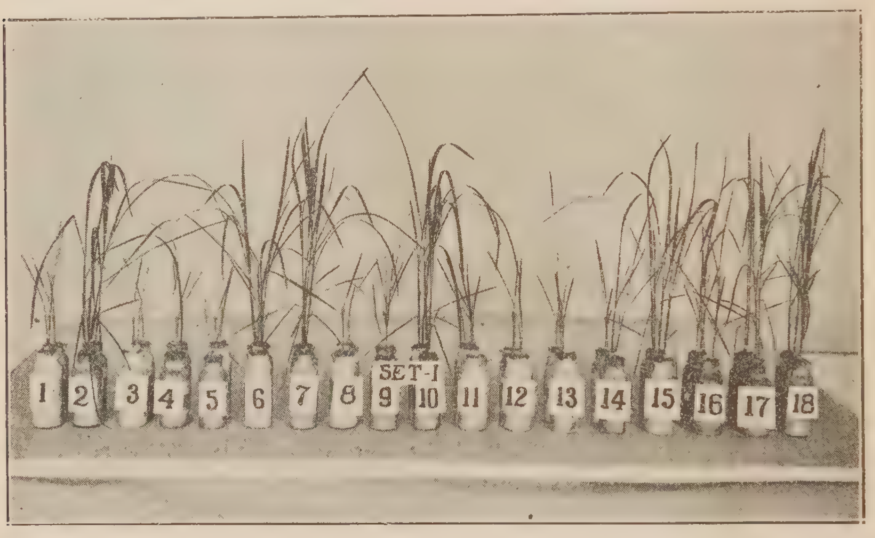

Fig. 3.—Cultures as in fig. 2, but run from March 25 to April 25, 1928.

e. Rain water caught from galvanized iron roof that had been painted with Sherwin-Williams "Red Kromik" paint. With the use of a large glass funnel, the stem end of which was inserted in a carboy, rain water from a galvanized iron roof that had been painted with Sherwin-Williams "Red Kromik" paint was collected. The rain water was as clear as that caught directly.

f. Water from Molawin Creek. Clear water from Molawin Creek was used in this study. In collecting this water, care was taken not to make the collection when the water was turbid. To have a large amount in stock, this water was stored in a clean carboy.

g. Tap water in Los Baños. Several demijohns full of tap water from the waterworks system of Los Baños were brought to the laboratory for use in this study. The water was very clear and its source is Dampalit River.

h. Water from Laguna de Bay. The water from Laguna de Bay collected for use in this study was rather dirty. It was taken about one hundred meters from the shore of Los Baños and after three days in the demijohns a thin layer of clay-like material settled at the bottom of the containers. The sediment was not removed and the solution was stirred up before using.

i. Water from an ordinary well. Water from an ordinary open well about fifteen meters in depth was also collected for use in this study. It was deposited in demijohns, and was as clear as the water taken from Molawin Creek.

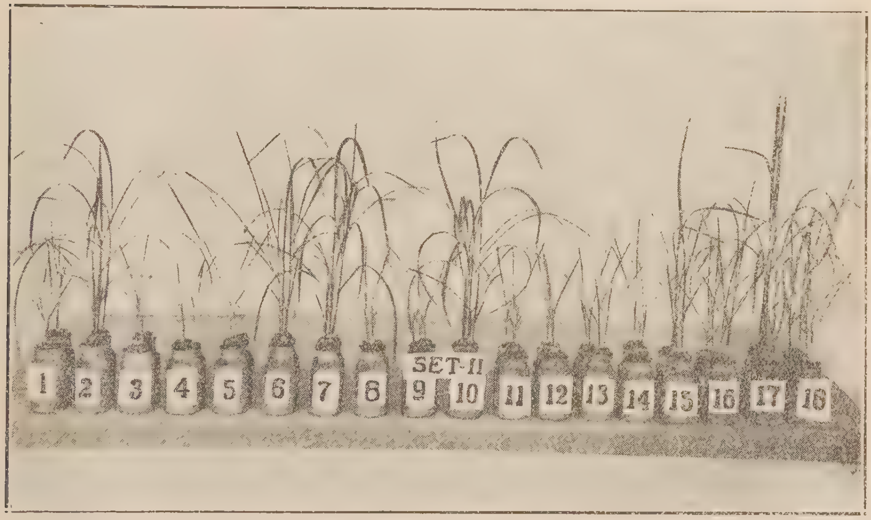

Fig 4.—Young rice plants, var. Barao, grown for thirty days, from March 10 to April 9, 1928, in complete culture solution in which Molawin Creek water was used as solvent; total concentration 0.0015 gram-molecule (of all salts taken together) per liter. (See table 3).

j. Distilled water. The distilled water was prepared in the Plant Physiology Laboratory. It was distilled by means of a Barnstead Double Wall Still run by electricity.

The plants

Two lowland rice varieties were used; namely, variety Roxas, the seeds of which were obtained from the Agronomy Department of the College of Agriculture, and the variety Barao, obtained from San Carlos, Pangasinan. Owing to the exhaustion in the Agronomy Department of the supply of the Roxas variety in the second year of experiment, variety Barao was used. All the plants that were grown in water taken from different sources were of the variety Roxas, and all of those grown in complete culture solution and in the solutions of ammonium sulfate were of the variety Barao.

To germinate the seeds, they were soaked in tap water for twenty-four hours and then spread evenly on a piece of moist blotting paper laid in a porcelain pan. The seeds were completely covered with another piece of moist blotting paper. Soon after the appearance of the radicles and plumules, the germinating seeds were carefully spread on paraffined bobbinet which had been stretched and tightly tied over a wide-mouthed museum jar. The jar was filled with tap water up to the rim so that the paraffined bobbinet rested on the surface of the water. The level of the water was maintained by frequent additions of tap water. This germinator was placed outside the Plant Physiology Building where the developing young plants could receive diffused light. The seedlings remained there until the leaves were about six centimeters high, then uniformly developed seedlings were selected for the cultures. The seedlings were transferred to bottles, inserting each one into a hole in the cork stopper and holding it in position by means of a cotton plug so that the roots could be in the solution. Care was taken not to let the seeds touch the culture solution. Each cork stopper was coated with paraffine and had three holes for holding the seedlings. To keep the roots in darkness, each culture bottle was doubly wrapped with an inner layer consisting of a piece of carbon paper and an outside one of a piece of Manila paper.

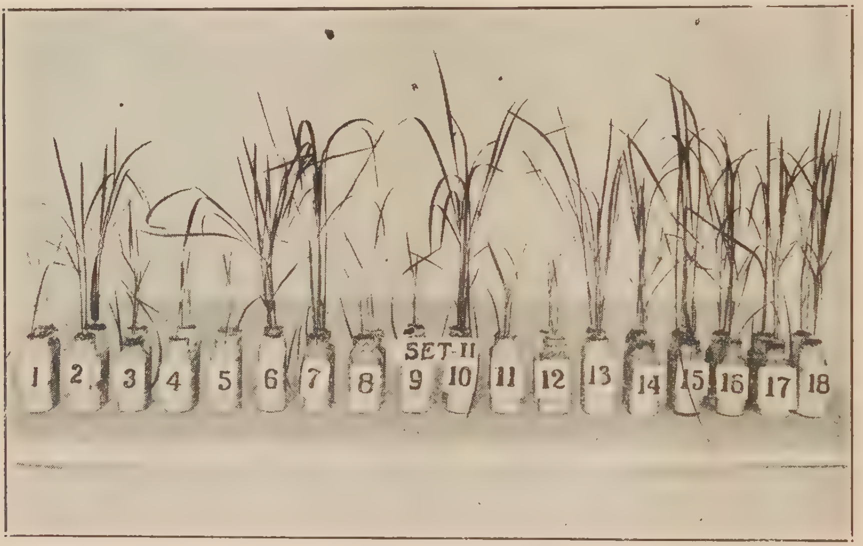

Fig. 5.—Cultures as in fig. 4, but run from March 25 to April 25, 1928.

The culture media

The salts contained in the culture solutions were first prepared singly in M/40 concentration. These salts were monopotassium phosphate, calcium nitrate, ammonium sulfate, and magnesium sulfate. All of these salts were "Baker's analyzed". In the preparation of the single salt stock solutions, distilled water was used as a solvent.

The culture media were prepared according to the proportions of the salts and concentrations of the solutions indicated in tables 2, 3, and 4, and the main solvent used was the water taken from Molawin Creek. The solvent that was used in the complete culture solutions which served as control was distilled water.

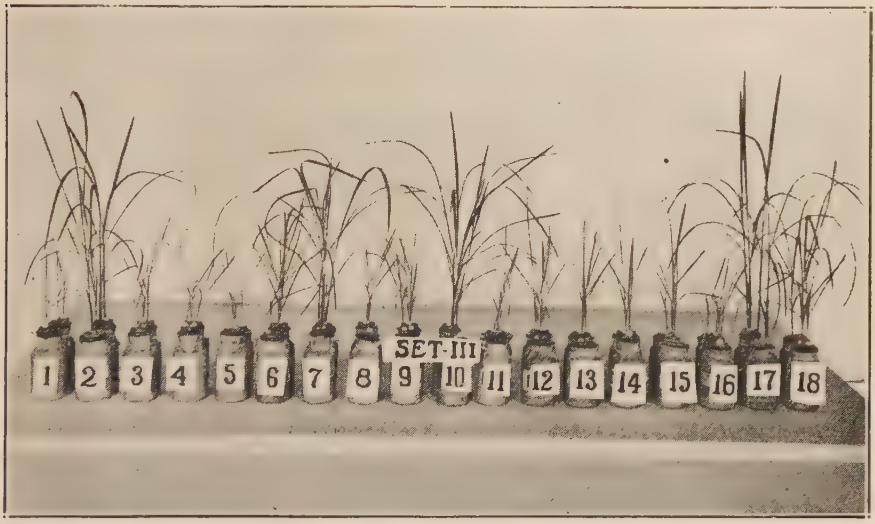

Fig. 6.—Young rice plants, var. Barao, grown for thirty days, from March 10 to April 9, 1928, in complete culture solution in which Molawin Creek water was used as solvent; total concentration 0.002 gram-molecule (of all salts taken together) per liter. (See table 4).

Each complete culture solution was prepared as follows: a 250 cc. volumetric flask was filled two-thirds full with creek water and into it the required amounts of salts were added one by one, using a graduated pipette. To prevent the formation of precipitates, the flask was shaken from time to time while the salts were being mixed. Then, some more creek water was added until the required amount of the culture solution was prepared. Six drops of ferric phosphate were added to every culture solution of 65 cc.

The culture sets were run in duplicate except the last ones, which were run only in one trial or set in triplicate. Three sets were run simultaneously each in duplicate, having the total concentrations of approximately 0.001, 0.0015, and 0.002 gram-molecule (of all the salts taken together) per liter. The culture solutions were changed or renewed at the end of every three days.

The control cultures

Espino's four-salt solution type A, having a total concentration of 0.002 gram-molecule (of all the salts taken together) per liter, was used as the control culture. This culture solution contained salts in the following proportions: one part of monopotassium phosphate, one and one-half parts of calcium nitrate, and one and one-half parts of ammonium sulfate, and four parts of magnesium sulfate. To show young rice plants in a normal state of development this solution was employed as a control culture for the sets of cultures in which most of the cultures were supplied only with rain or tap water.

Other control cultures were employed in this study. These were the cultures in which only distilled water or creek water was used as the culture medium for the young rice plants. These culture media were employed not with the expectation of obtaining well developed plants but to show their nutritive deficiencies when compared with the complete and well balanced culture media in which either distilled or creek water was employed as the solvent. These control cultures, together with a modified Espino's 4-salt type A, were employed for comparison with the major or main cultures in the complete solutions and with the solutions of ammonium sulfate in creek water. The modified Espino's 4-salt culture solution type A had 1 part each of KH_2PO_4, $Ca(NO_3)_2$, and $(NH_4)_2SO_4$ and 8 parts of $MgSO_4$.

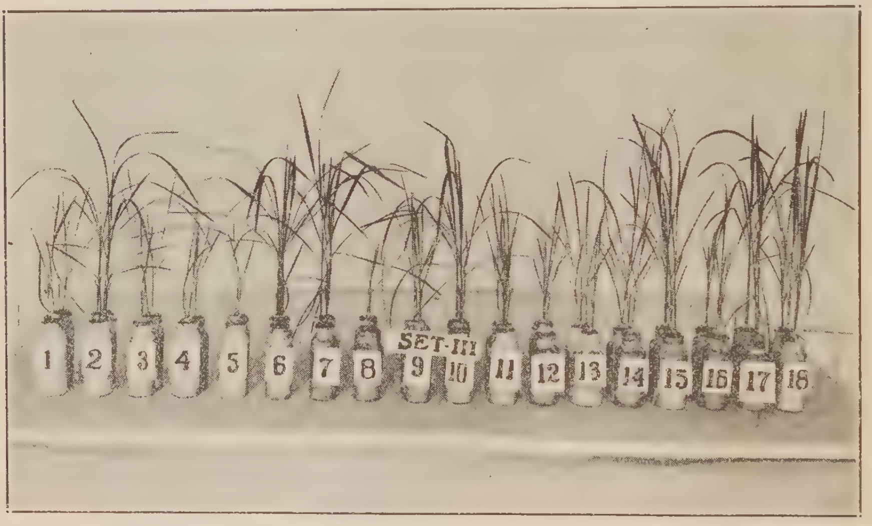

Fig. 7.—Cultures as in fig. 6, but run from March 25 to April 25, 1928.

EXPERIMENTS AND RESULTS

Plants grown in water obtained from different sources

To determine the comparative nutritive values of water obtained from different sources, a set of ten cultures, each in duplicate, was started on

April 14, 1926. The cultures were run for thirty days. The water was obtained from different sources. About 120 cc. of each type[2] were used in each culture and the water was changed every other day. At the end of thirty days, the plants were harvested. The height of tops and the length of roots were determined. The tops and the roots obtained from each culture were dried separately. Then, their respective dry weights were determined on an analytical balance. The data obtained were recorded.

A similar set of cultures was started on May 25, 1926 and harvested thirty days later. Data were gathered under the same criteria that had been employed in the first set. This set of cultures was repeated five more times—on June 28, August 2, September 5, November 2, and December 5, 1926, making in all seven trials.[3] As in the first set, data were gathered at the end of each experimental period, under the criteria, (a) height of top, (b) length of root, (c) dry weight of tops, and (d) dry weight of roots. In order to obtain the dry weight of the whole plant, the dry weights of the tops and of the roots from each culture were combined and the result is considered another criterion of results in this study.

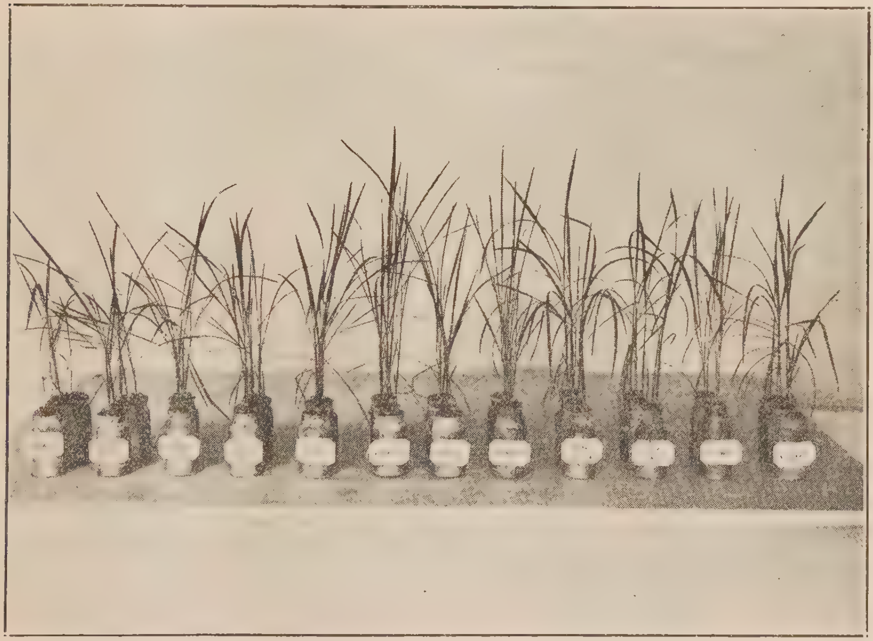

Fig. 8.—Young rice plants, var. Barao, grown for thirty days in solutions of ammonium sulfate at different molecular concentrations in Molawin Creek water. Cultures 9 to 12 are control. (See table 5).

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[2] Type refers to the water obtained from any one source.

[3] With the tap water from Los Baños only two trials were made; only five trials with the water from Laguna de Bay.

Owing to the apparent similarity of the results obtained from similar cultures in the seven trials, or sets, it was found possible to present in this report only the averages of the data under each criterion gathered from the seven sets of cultures. The data on averages are recorded in table 1[4]. A representative set of these seven sets of cultures was photographed at the end of an experimental period (see fig. 1) or when the plants had been in the culture media for thirty days.

Plants grown in complete culture solutions using Molawin Creek water as solvent

The young rice plants that were supplied with Molawin Creek water were apparently not quite normally developed. As was expected, this water was nutritively deficient in one way or another. In order to determine in what way this water was nutritively deficient, three sets of eighteen cultures, each in duplicate, were run from March 10 to April 9, 1928. One set of each culture had a total concentration of approximately[5] 0.001 gram-molecule (of all the salts taken together) per liter; in another set, 0.0015 gram-molecule; and in the third set, the total concentration of each culture solution was approximately 0.002 gram-molecule. Each set of cultures was run for thirty days and each culture had 65 cc. of the culture solution. The solutions were changed or renewed every other day. The proportions of the salts in each culture medium together with data as *relative values* under *a* gathered at the end of the experimental period are shown in tables 2, 3 and 4. At the time of harvest, the plants were photographed (see fig. 2, 4 and 6).

These three sets of cultures were again run on March 25, 1928, and the plants were harvested on April 25, 1928, or thirty days later. The data obtained from these sets of cultures, as *relative values*, are presented under *b* in tables 2, 3 and 4. When the plants were ready for harvest they were photographed (see fig. 3, 5 and 7).

Plants grown in ammonium sulfate solutions

The apparently good results that were obtained from the culture solutions in which the amount of ammonium sulfate was greater than any of the other salts suggested that for a suitable culture medium for young rice plants the water from Molawin Creek was too deficient in ammonium sulfate. To determine the extent of this deficiency, a set of twelve culture, each in triplicate, was started on April 15, 1928. The cultures were harvested thirty days later. Only ammonium sulfate was added to the creek water. Various concentrations were tried (see table 5). The usual trace of iron in the form of ferric phosphate was added to each culture medium, which was only 65 cc. Owing to the limited amount of the culture medium used, it was changed, or renewed every other day so that the plants grown in it could have about the same amount of ammonium sulfate during the experimental period of thirty days. At the end of this period, the plants were photographed (see fig. 8) their external appearances were observed, and the height of tops and lengths of roots measured. The dry weight of tops, as well as of roots, were determined. The data thus gathered, as *relative values* are shown in table 5.

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[4] The records of the original data are on file in the Department of Plant Physiology.

[5] The composition of the water from Molawin Creek has not been determined.

For comparison with the nutritive values of ammonium sulfate solution in different concentrations, pure creek water and certain complete, well balanced culture solutions for young rice plants were included in this set of cultures (see table 5).

Criteria of results

The criteria that are used as the bases of comparison of the nutritive values of the different culture media here tested are: (a) height of tops, (b) length of the roots, (c) dry weight of tops, (d) dry weight of roots, (e) dry weight of tops and of roots and (f) external appearance of plants. The data under these criteria (see tables 1-5) were obtained as follows:

a. Height of tops. At the end of the experimental period of thirty days, the plants were removed from the cork stoppers of the culture bottles. The height of tops of the plants from each culture was measured from the point of attachment of the seeds to the tip of the tallest leaf. The data thus gathered are recorded in the table under this criterion.

b. Length of roots. The data under this criterion were obtained by measuring the length of roots from each culture from the point of attachment of the seeds to the tip of the longest root.

c. Dry weight of tops. The plants from the different cultures were harvested separately and dried in an electric oven at a temperature of about 100°C. After drying, the seeds were detached and the tops were severed from the roots at the point of attachment of the seed to the plant. The dry weight of the tops from each culture was determined on an analytical balance.

d. Dry weight of roots. The dried roots from each culture referred to in the preceding paragraph were weighed together on an analytical balance.

e. Dry weights of tops and roots. To find the dry weight of all the plants from each culture, the weights of the tops and of the roots were combined.

f. External appearance of plants. At the end of the experimental period of thirty days, the general appearance of the plants grown in the different culture media were noted. The results of this observation are recorded in tables 1 to 5.

DISCUSSION OF RESULTS

In accordance with the objects of this study, the data in tables 1 to 5, together with the illustrations in figures 1 to 8, are here presented to show (a) the relative nutritive values of water obtained from different sources for the young rice plants, (b) the extent of the nutritive deficiency of Molawin Creek water for the young rice plants, and (c) the nutritive value of the creek water when only ammonium sulfate was added to it. The results under these three aspects of this study are discussed in this paper.

Nutritive values of water from different sources

Inspection of the data in table 1 and of the illustrations in fig. 1, will show, as was expected, that with the use of the different kinds of water here tested the young rice plants were unable to grow well. The plants were either extremely stunted in growth and chlorotic in appearance or were rather slender, with leaves quite chlorotic and pointing upwards. These results conclusively show that something to make it nutritively suitable for the young rice plants was lacking in the water obtained from any one of the sources considered.

The water from the different sources produced young rice plants of different degrees of development (see table 1 and fig. 1). Relatively speaking, the best developed plants were obtained from the cultures supplied either with rain water caught from an old nipa roof, or with the water from the creek. An appreciable growth and development were also obtained when the young rice plants were supplied with water from Laguna de Bay, or with rain water caught from cogon roof or with tap water from Los Baños. The water used with the rest of the cultures either produced not much growth or actually proved toxic to the plants. Of this last set of cultures, the water from an ordinary open well was the most nutritious. With the plants watered with rain water caught directly and from galvanized iron roof (either painted or not painted) the growth was extremely poor. This case of extremely poor development of the plant seems to suggest either the absence from the rain water thus collected of certain growth-producing substances (mineral salts) or the presence in the rain water caught from galvanized iron roof (especially the painted one) of a substance or substances really toxic to the young rice plants.

The extent of the nutritive deficiency of Molawin Creek water

Young rice plants were grown in complete culture solutions in which Molawin Creek water was used as solvent instead of distilled water. In some of these culture media, it was found possible to grow the plants well (see tables 2, 3 and 4, and figures 2, 3, 4, 5, 6, and 7). This finding suggests that it is possible to ascertain empirically the amounts and kinds of salts that should be added to Molawin Creek water to make it a suitable culture medium for the young rice plants.

After a more thorough study of the data in tables 2, 3 and 4 and of the illustrations in figures 2, 3, 4, 5, 6, and 7, it appears that it is possible to select or segregate the exceptionally good cultures from the poor cultures. To accomplish this the three consecutively highest records under each criterion and the three lowest records in these tables were arbitrarily selected and are indicated by H's and L's, respectively. For convenience of study of the results, all the cultures that show at least 4 H's out of the maximum 10 H's under the different criteria were selected and their salt proportions recorded in table 6.

Likewise, the cultures that show at least 3 L's out of the maximum 10 L's under each criterion were selected in their salt proportions shown in table 7.

The data in table 6 plainly show that under the three total molecular concentrations tried, cultures 2, 7 and 10 are represented. These cultures were, therefore, the "good" ones and are characterized by possessing low content of KH_2PO_4 and of $Ca(NO_3)_2$; relatively high content of $(NH_4)_2SO_4$; and low to medium amounts of $MgSO_4$. It appears, therefore, that probably a relatively high content of $(NH_4)_2SO_4$ is the determining factor in the improvement of the nutritive value of the creek water for young rice plants. The illustrations in figures 2, 3, 4, 5, 6, and 7 also plainly show that the cultures 2, 7 and 10 gave about the best development of the young rice plants under the three total concentrations tried. With these cultures may probably be included culture 6, and possibly also, (but with slight discrepancy in results obtained from repeated trials) culture 15. In both cultures 6 and 15, ammonium sulfate was also used in relatively large amounts. The apparent beneficial effects that $(NH_4)_2SO_4$ gave to the young rice plant in this study once more corroborates similar findings reported by Kelley (1911), Espino (1920), and others.

The poor cultures (see table 7) are characterized by low contents of $(NH_4)_2SO_4$ and usually high contents of KH_2PO_4 and low or high contents of either $Ca(NO_3)_2$ or $MgSO_4$. These findings once more emphasize the important role that ammonium sulfate plays in improving the nutritive value of the creek water for the young rice plants. They plainly show too, that while it was possible to improve the nutritive value of the creek water by a judicious addition of inorganic salts, it was likewise possible to make this water more nutritively deficient, or even toxic to the young rice plants, upon the addition of the same mineral salts only in different proportions. The toxic effect (that is, worse than the effect of the creek water when used alone) was most noticeable in cultures 1, 3, 4, 5, 8, 9, 11, 12, 13 and 14. With the exception of cultures 13 and 14, these cultures had only one part each of $(NH_4)_2SO_4$.

Comparing the results obtained from the present study with those already reported on the subject[6], there appears a discrepancy which is not easy to explain. This discrepancy refers to the fact that the best culture solutions for the young rice plants, varieties Wateribune, Hambas, or Roxas, had the following salt proportions and in total molar concentration of 0.002

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[6] Espino, (1920); Espino and Estioko (Unpublished).

gram-molecule (of all the salts taken together) per liter: 1 part KH_2PO_4, 1 to 1½ parts $Ca(NO_3)_2$, 1 to 1½ parts $(NH_4)_2SO_4$ and 4 to 16 parts $MgSO_4$. The solvent was distilled water. In the present study however, in which the distilled water was replaced by water from Molawin Creek, the best cultures had 6 to 12 parts $(NH_4)_2SO_4$. Moreover, unlike in the reported cases in which the limiting, or the determining factor seemed to be the $MgSO_4$, in the present study the supply of this salt in the culture medium could either be extremely low or of medium amounts. The rice plant employed in the present study was variety Barao, a lowland type. The amount and nature of the data on hand do not warrant further consideration as to whether these apparent discrepancies were due to the varietal differences of the plants studied or to something present in the creek water.

Growth and development of the plant in ammonium sulfate dissolved in Molawin Creek water

The apparent excellent development of the young rice plants supplied with the complete culture solutions containing 6 to 12 parts $(NH_4)_2SO_4$ and with rather low content of each of the other salts has led to a further inquiry. In this inquiry determination was made as to whether the addition of ammonium sulfate alone to the creek water would make it nutritively of value to the young rice plant.

Inspection of the data obtained from this part of the study (see table 5) and of the illustrations in figure 8, will show that although fairly well developed plants were obtained from the culture media in which only ammonium sulfate was present, yet most of these plants had leaves dried at tips and pointing upward. These results corroborate Macasaet's (1927, unpublished) findings and show some deficiency in the nutritive value of the solution. Moreover, the data in table 5 also show that under the criterion of dry weight of tops and of roots cultures 11 and 12 (both control cultures complete and well balanced solutions) were better than any of the cultures in which only ammonium sulfate was present. With the exception of the data on length of root, which is not a good criterion to use in this study, the nutritive value of the creek water was (in some cases) improved materially by the addition of ammonium sulfate. The data in table 5 indicate that the beneficial dilution or concentration of the solution of this salt ranges from 0.0000625 to 0.0015 molar. Of the different concentrations tried, the best for the young rice plant was 0.00025 molar.

SUMMARY AND CONCLUSIONS

1. As shown by the growth of the young rice plants, Molawin Creek water and the rain water caught from an old nipa roof were relatively the most suitable as a nutrient solution; while rain water directly collected from the air and that caught from a galvanized iron roof painted or not painted were the least nutritious, or were even rather toxic.

2. The "good" cultures in the sets of *complete* culture solutions in which creek water was used as solvent, are characterized by possessing low contents of KH_2PO_2 and of $Ca(NO_3)_2$; relatively high content of $(NH_4)_2SO_4$; and low to medium amounts of $MgSO_4$.

3. The "poor" cultures in the sets of *complete* culture solutions in which creek water was used as solvent are characterized by low contents of $(NH_4)_2SO_4$ and usually high contents of KH_2PO_4 and low or high contents of $Ca(NO_3)_2$ or $MgSO_4$.

4. The nutritive value of Molawin Creek water was materially improved for the young rice plant upon addition to this water of ammonium sulfate ($(NH_4)_2SO_4$) in amounts sufficient to make solutions in concentrations ranging from 0.0000625 to 0.0015 molar.

5. While it was possible to improve the nutritive value of the creek water by a judicious addition of certain inorganic salts, it was likewise possible to make this water nutritively poor or even toxic to the young rice plants upon the addition of the same mineral salts only in different proportions.

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TABLE 1

Average data[a] *showing the development of young rice plants grown in water obtained from different places*

CULTURE MEDIA	AVERAGE LENGTH		DRY WEIGHT			EXTERNAL APPERANCE OF PLANTS
	Top	Root	Top	Root	Top and root	
Rain water caught from nipa roof	83	167	86	66	81	Plants fairly developed, leaves pale green, pointed upward, tips dry.
Water from Molawin Creek	76	165	80	62	75	ditto
Tap water from Los Baños[b]	73	130	74	64	72	ditto
Water from Laguna de Bay	69	156	75	58	71	ditto
Rain water caught from cogon roof	69	164	75	57	70	ditto
Water from an ordinary well	61	150	67	48	62	Plants poorly developed, leaves yellowish, pointed upward, tips dry.
Rain water caught by glass funnels from air	46	44	58	34	50	Plants stunted in growth and extremely chlorotic.
Rain water caught from galvanized iron roof	46	147	65	27	50	ditto
Rain water caught from galvanized iron roof painted with "red Kromick paint"	40	77	34	19	31	ditto
Distilled water	42	145	39	19	35	ditto
Espino's 4-salt solution	100 (33.8 cm.)	100 (12.3 cm.)	100 (0.145 gm.)	100 (0.045 gm.)	100 (0.190 gm.)	Normally developed.

[a] The *actual value* under each criterion in the control was arbitrarily taken as 100; the other *actual values* under the same criterion were reduced relatively. The new values are here termed *"relative values."*

[b] Average of two trials, each trial was run in duplicate.

TABLE 2

Data[a] *showing the relative development of young rice plants grown in culture solutions containing salts in different proportions dissolved in water from Molawin Creek, total concentration approximately 0.001 gram-molecule*

CULTURE NO.	SALT PROPORTIONS	AVERAGE LENGTH				DRY WEIGHT						GENERAL APPEARANCE OF PLANTS
	KH_2PO_4: $Ca(NO_3)_2$: $(NH_4)_2SO_4$: $MgSO_4$	Top		Root		Top		Root		Top and root		
		a	b	a	b	a	b	a	b	a	b	
1	1:1:1:12	39	46	117	147	17	24	23	30	18	25	Plants stunted in growth and extremely chlorotic.
2	1:1:12:1	98 H	107 H	104	112	100 H	127 H	77 H	92 H	96 H	120 H	Plants normally developed leaves dark green well spread; plenty gray roots.
3	1:12:1:1	40	41	96	108 L	17 L	21 L	21 L	27	18 L	22	Plants stunted in growth and estremely chlorotic.
4	12:1:1:1	38 L	35 L	101	109	20	16	22	25	20	18 L	ditto
5	6½:6½:1:1	35 L	37 L	91 L	99 L	15 L	18	17 L	23 L	16 L	19 L	ditto
6	1:6½:6½:1	65	90	101	152 H	32	90	30	66	32	86	Plants normally developed, leaves green, not well spread; plenty gray roots.
7	1:1:6½:6½	108 H	111 H	120	127	109 H	133 H	89 H	103 H	105 H	127 H	Plants normally developed, leaves dark green, well spread; plenty gray root.
8	6½:1:1:6½	43	39	137 H	101 L	18	19 L	22	25	19	21	Plants stunted in growth and extremely chlorotic.
9	1:1:1:8	42	48	149 H	133	19	24	22	28	20	25	ditto
10	1:1:8:1	105 H	111 H	106	129	108 H	131 H	86 H	97 H	104 H	125 H	Plants normally developed, leaves dark green, well spread; plenty gray roots.
11	1:8:1:1	52	40	92	115	24	21	23	28	24	22	Plants stunted in growth and extremely chlorotic.
12	8:1:1:1	38 L	40	85 L	134	17 L	19 L	21 L	24 L	18 L	20 L	ditto
13	6:3:3:3	51	38 L	97	118	23	20	22	24 L	23	21	ditto
14	3:6:3:3	42	65	82 L	157 H	22	28	23	27	22	28	Plants abnormally developed, leaves narrow and light green, pointed upward, tips dry; roots brown.
15	3:3:6:3	73	97	93	141	36	122	25	85	34	121 H	Plants abnormally developed, leaves green, pointed upward, many gray roots.
16	3:3:3:6	56	72	93	120	30	40	25	28	29	38	Plants abnormally developed, leaves light green, pointed upward, tips dry, many brown roots.
17	Creek water	71	84	131 H	181 H	36	76	35	85	36	78	Plants abnormally developed, leaves light green, pointed upward, tips dry, few long brown roots.
18	1:1:1:8	100 (40.25 cm.)	100 (36 cm.)	100 (12.1 cm.)	100 (11.65 cm.)	100 (.193 gm.)	100 (.1495 gm.)	100 (.0405 gm.)	100 (.0355 gm.)	100 (.2335 gm.)	100 (.185 gm.)	Plants normally developed.

[a] The *actual values* under each criterion in the control was arbitrarily taken as 100; the other *actual values* under the same criterion were reduced relatively. The new values are here termed *"relative values"*.

TABLE 3

Data showing the relative development of young rice plants grown in culture solutions containing salts in different proportions, dissolved in water from Molawin Creek; total concentration approximately 0.0015 gram-molecule

CULTURE NO.	SALT PROPORTIONS	AVERAGE LENGTH				DRY WEIGHT						EXTERNAL APPEARANCE OF PLANTS
	KH_2PO_4: $Ca(NO_3)_2$: $(NH_4)_2SO_4$: $MgSO_4$	Top		Root		Top		Root		Top and root		
		a	b	a	b	a	b	a	b	a	b	
1	1:1:1:12	41	39 L	105	137	24	18 L	40	27 L	27	20 L	Plants stunted in growth and extremely chlorotic.
2	1:1:12:1	97 H	99	107	112 L	115 H	124	80 H	76	109 H	115	Plants normally developed, leaves dark green, well spread, plenty of gray roots.
3	1:12:1:1	40	51	89	117	23	23 L	38	28	25	27	Plants stunted in growth and extremely chlorotic.
4	12:1:1:1	36 L	41 L	82	138	19 L	24	40	24 L	23 L	24 L	ditto
5	6½:6½:1:1	44	38 L	86	126	22	27	38	23 L	25 L	21 L	ditto
6	1:6½:6½:1	90 L	108	99	134	66	123	54	72	64 H	113	Plants normally developed leaves green, not well spread, plenty gray roots.
7	1:1:6½:6½	105 H	117 H	118 H	125	106 H	148 H	75 H	107 H	58	141 H	Plants normally developed, leaves dark green, well spread, plenty gray roots.
8	6½:1:1:6½	41	50	114 H	161 H	21 L	26	35 L	28	23	26	Plants stunted in growth and extremely chlorotic.
9	1:1:1:8	41	42	81 L	138	21	23	40	29	24	24	ditto
10	1:1:8:1	98 H	113 H	107	109 L	110 H	178 H	77 H	127 H	106 H	147 H	Plants normally developed, leaves dark green, well spread, plenty gray roots.
11	1:8:1:1	41 L	84	68 L	134	20 L	24	35 L	30	23 L	25	Plants stunted in growth and extremely chlorotic.
12	8:1:1:1	40 L	50	80 L	100 L	23	26	40	31	26	27	ditto
13	6:3:3:3	48	93	95	157 H	24	74	36	48	26	69	Plants abnormally developed, leaves light green-pointed upward, tips dry, many brown roots.
14	3:6:3:3	41	83	109	133	22	50	40	32	26	48	ditto
15	3:3:6:3	82	114 H	99	129	56	161 H	49	135 H	55	156 H	Plants abnormally developed, leaves light green-pointed upward, plenty gray roots.
16	3:3:3:6	75	86	107	152	43	83	46	58	44	78	ditto
17	Creek water	71	84	131 H	181 H	36	76	35 L	85	36	78	Plants abnormally developed, leaves light green-pointed upward, tips dry, few long brown roots.
18	1:1:1:8	100 (40.25 cm.)	100 (36 cm.)	100 (12.1 cm.)	100 (11.65 cm.)	100 (.193 gm.)	100 (.1495 gm.)	100 (.0405 gm.)	100 (.0355 gm.)	100 (.2335 gm.)	100 (.185 gm.)	Plants normally developed.

[a] The *actual value* under each criterion in the control was arbitrarily taken as 100; the other *actual value* under the same criterion were reduced relatively. The new values are here termed "*relative values*".

TABLE 4

Data[a] showing the relative development of young rice plants grown in culture solutions containing salts in different proportions, dissolved in water from Molauin Creek; total concentration approximately 0.002 gram-molecule

CULTURE NO.	SALT PROPORTIONS	AVERAGE LENGTH				DRY WEIGHT						EXTERNAL APPEARANCE OF PLANTS
	KH_2PO_4: $Ca(NO_3)_2$: $(NH_4)_2SO_4$: $MgSO_4$	Top		Root		Top		Root		Top and Root		
		a	b	a	b	a	b	a	b	a	b	
1	1:1:1:12	33 L	52	73 L	156 H	16	23	25	27	17	24 L	Plants stunted in growth and extremely chlorotic.
2	1:1:12:1	98 H	99	102 H	113	63 H	98 H	59 H	48	63 H	89 H	Plants normally developed, leaves green, small, not well spread, plenty gray roots.
3	1:12:1:1	38	57	90	160 H	18	25	19 L	24 L	18	25	Palnts stunted in growth and extremely chlorotic.
4	12:1:1:1	37	48	69 L	133	16	23 L	21	27	17 L	24	ditto
5	6½:6½:1:1	35 L	42 L	74	138	16	25	21	25	17	25	ditto
6	1:6½:6½:1	58	104 H	85	94 L	32	97 H	28	70 H	32	92 H	Plants normally developed, leaves green, not well spread, plenty of gray roots.
7	1:1:6½:6½	97 H	106 H	122 H	109	92 H	107 H	64 H	65 H	87 H	100 H	Plants normally developed, leaves dark green, not well spread, plenty of gray roots.
8	6½:1:1:6½	45	41 L	95	147	18	14 L	21	25 L	19	16 L	Plants stunted in growth and extremely chlorotic.
9	1:1:1:8	41	57	78	120	17	30	17 L	28	17	30	ditto
10	1:1:8:1	91 H	103 H	91	102 L	75 H	91	56 H	58 H	71 H	85	Plants normally developed, leaves dark green, well spread, plenty of gray roots.
11	1:8:1:1	36	59	78	124	14 L	31	20 L	25 L	15 L	30	Plants stunted in growth and chlorotic.
12	8:1:1:1	46	50	84	104 L	22	21 L	22	25	22	22 L	ditto
13	6:3:3:3	39	60	64 L	129	15 L	33	22	28	16 L	32	ditto
14	3:6:3:3	41	79	76	122	20	43	22	35	20	41	Plants abnormally developed, leaves pale green, small, and pointed upward, gray roots.
15	3:3:6:3	51	95	93	139	30	81	20	52	28	76	Plants abnormally developed, leaves pale green, not well spread, pointed upward, plenty of gray roots.
16	3:3:3:6	34 L	41 L	78	126	15 L	29	23	28	17	29	Plants abnormally developed, leaves light green, tips dry, pointed upward, brown roots.
17	Creek water	71	84	131 H	181 H	36	76	35	85 H	36	78	Plants abnormally developed, leaves light green, pointed upward, tips dry, long brown roots.
18	1:1:1:8	100 (40.25 cm.)	100 (36 cm.)	100 (12.1 cm.)	100 (11.65 cm.)	100 (.193 gm.)	100 (.1495 gm.)	100 (.0405 gm.)	100 (.0355 gm.)	100 (.2335 gm.)	100 (.185 gm.)	Plants normally developed.

[a] The *actual value* under each criterion in the control was arbitrarily taken as 100; the other *actual values* under the same criterion were reduced relatively. The new values are termed "*relative values*".

TABLE 6

Showing mainly the salt proportions of the "good" cultures

CONCENTRATION OF CULTURE SOLUTION	CULTURE NO.	SALT PROPORTIONS (KH_2PO_4; $Ca(NO_3)_2$ $(NH_4)_2SO_4$; $MgSO_4$)	NUMBER OF H'S
0.001	2	1:1:12:1	7 or 8 H's
	7	1:1:6½:6½	8 H's
	10	1:1:8:1	9 H's
0.0015	2	1:1:12:1	4 H's
	7	1:1:6½:6½	8 H's
	10	1:1:8:1	8 H's
	15	3:3:6:3	4 H's
0.002	2	1:1:12:1	7 H's
	6	1:6½:6½:1	4 H's
	7	1:1:6½:6½	9 H's
	10	1:1:8:1	5 H's

TABLE 7

Showing mainly the salt proportions of the "poor" cultures

CONCENTRATION OF CULTURE SOLUTION	CULTURE NO.	SALT PROPORTIONS (KH_2PO_4; $Ca(NO_3)_2$; $(NH_4)_2SO_4$; $MgSO_4$)	NUMBER OF L'S
0.001	3	1:12:1:1	4 L's
	4	12:1:1:1	3 L's
	5	6½:6½:1:1	7 L's
	12	8:1:1:1	8 L's
0.0015	1	1:1:1:12	4 L's
	4	12:1:1:1	6 L's
	5	6½:6½:1:1	4 L's
	11	1:8:1:1	5 L's
	12	8:1:1:1	3 L's
0.002	1	1:1:1:12	3 L's
	4	12:1:1:1	3 L's
	8	6½:1:1:6½	4 L's
	11	1:8:1:1	4 L's
	12	8:1:1:1	3 L's
	13	6:3:3:3	3 L's
	16	3:3:3:6	3 L's

A REPORT OF TWO MONTHS' EXTENSION WORK IN THE VISAYAN ISLANDS

MOISES M. KALAW

The trip lasted from September 5 to November 6, 1928. The primary object was to supervise the construction of copra driers, following the general plan of the College Copra Drier, in two places, one in Leyte, at the hacienda in Puerto Bello, Merida; and the other in Oriental Negros, on the farm of Mr. Espiridion Villegas in Tabon, Vallehermoso. Following instructions, a stop-over was first made at the Cabano Coconut Estate in Jordan, Guimaras Island, where it was reported a College Copra Drier was being used.

THE CABANO DRIER (IN GUIMARAS ISLAND)

The Cabano drier was an exact reproduction of the College Copra Drier as described in Circular No. 11 with some practical additions and minor changes in dimensions. The dimensions were based largely on the table on page 14, column 3 of the College Circular No. 11. This column has this heading, "(6 ft.×40 ft. 1,000 nuts loading capacity, 2,400 to 3,000 nuts per 24 hours)". The changes in the dimensions were in the depth of the combustion chamber and in the width and depth of the oven. Apparently these modifications did not affect greatly the efficiency of the drier but they produced some inconvenience which will be explained later.

The drier is built of strong materials. Most of the parts used are the same as those suggested in the circular. The additional parts are found to be very practical. Clay brick, cement, sand and gravel were used in the masonry work. Iron plates, measuring 6′×10′×1/8″, and G. I. plates for roofing were used in covering the combustion chamber. The heating chamber and the cover were made of wood and galvanized iron. The heating chamber was supported by large posts which served also as attachment for rails for the trays. The trays were of wood with wire screen for a floor. The parts used which are not suggested in the circular were the wheels of the trays and the angle iron bar used as rails for the trays. Another practical addition was the device for pulling the trays. It was a simple wooden derrick consisting of a wooden shaft with the wheel of a cart as flywheel. These additions were found to be very practical and will be adopted in future constructions of the drier.

The expenses incurred in building the Cabano drier may be considered a good standard for future constructions. The Cabano Estate had to purchase everything for the drier, as there was no material on hand. So

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[1] Experiment Station contribution No. 604. Read before the Los Baños Biological Club February 14, 1929. Received for publication February 16, 1929.

the expense is an exact estimate of the total cost of the drier. Some allowance, however, should be made for the transportation of the materials from Iloilo to Cabano. Table 1 is the bill of materials for the Cabano drier, furnished by Mr. H. Roelli, president of the Cabano Corporation.

According to Circular No. 11, the College drier has a capacity of about 3,000 nuts per 24 hours. But in Cabano the capacity of the drier was very much greater. Their record showed that they could dry from 15 to 20 piculs in 10 hours. In Cabano about 240 nuts makes a picul of copra. Hence the capacity of the drier in number of nuts is 3,600 to 4,800 in 10 hours. This increase in capacity of the drier is due to the practice of putting into the drier meat which has been partially sundried. The nuts are husked and divided into halves, as is done in Laguna. Then the drier is filled and the rest of the nuts are put in the sun.

TABLE 1

Bill of materials for the Cabano drier

4 pcs. angle iron bar 2″×2″×20′ with holes		₱28.12
400 screws No. 14 2″ long	₱11.67	
2 augers at ₱1.85	3.70	
Total	₱15.37	
Less 10% discount	1.54	
		13.83
9 G.I. sheets 7′×24 G. at ₱2.60		23.40
2 pcs. iron plates 6′×10′×1/8″		96.14
36 (bolts) 3/8″×39-1/2″		9.00
30.5 meters wire screen, 1/4″ mesh, 20 gauge		221.13
72 sash rollers		57.60
16 pcs. W. I. bar for (grating)		5.60
4 barrels cement (Apo)		26.00
6 pcs. G. I. plaine		18.60
6 pairs hinges 3″×3″ with screws		3.67
1 piece iron for door of oven		5.75
44 pcs. G. I. for roofing, 8′ at ₱3.05		134.20
22 pcs. G. I. for roofing, 9′ at ₱3.45		75.90
5 kg. nails 2-1/2″		2.25
Lumber		
26 pcs. lauan, 2×4×14		28.08
8 pcs. lauan, 2×4×12		5.76
5 pcs. lauan, 2×4×16		4.86
3 pcs. lauan, 2×4×18		3.24
2 pcs. lauan, 2×4×24		2.88
11 pcs. lauan, 2×6×12		11.88
4 pcs. lauan, 2×6×24		12.00
7 pcs. lauan, 2×6×18		11.97
4 pcs. lauan, 2×6×18		6.84
5 pcs. lauan, 2×6×20		9.50
11 pcs. lauan, 2×6×12		12.54
7 pcs. lauan, 3×6×20		18.90
20 pcs. lauan, 2×4×12		14.40
40 pcs. lauan, 1×2×12		7.20
4 pcs. lauan, 2×6×56		5.04
24 pcs. yacal, 2×6×12		77.76
Transportation		13.55
Total expense for materials		₱969.22
Labor and supervision		405.00
Grand Total		₱1,374.22

When it was raining the half nuts were placed in such a way that the meat would not get wet. After a day of continuous sunshine, the meat was separated from the shell. In this way there was a good supply of fresh meat for the drier. Sun-drying is very slow, but when the meat has been exposed to sunshine for a good while it is very easily dried in the copra drier. While I was there, there were 40,000 nuts to be made into copra. The manager assured me that the meat could be dried in one and a half weeks. Kowing that the capacity of the drier, according to the circular is only about 3,000 in 24 hours I could hardly believe him. But after seeing the method and gètting the record of the daily output of copra with the use of the drier, I realized that this was possible. If the method common in Laguna (that is, not resorting to sun-drying) had been followed, I think it would have taken perhaps a month to dry the 40,000 nuts. I believe that his method is the most practical way of using the drier.

The drier has been in efficient use for over a year, but it has some defects which lessen its efficiency to a certain extent and which cause inconvenience to the workers. Most of these defects were easily remedied but only reconstruction can rectify the most serious one. The defects which were at once remedied were really mistakes in construction which would not have been made by one familiar with the drier. The most conspicuous of these defects was the boring of the air vents. The directions in the circular state that they are to be placed above the iron plate, but in the Cabano drier they were below the iron plate (in the wall of the combustion chamber). Thus a great loss of heat resulted. These holes were subsequently patched up. The first time I saw the drier volumes of smoke were coming out of the mouth of the oven. I noticed that the chimney was rather low so there was not enough draft, consequently the smoke came back and out of the mouth of the oven. This was very annoying to the fireman. When the height of the chimney was increased five feet, the smoke all went out of the chimney as it should.

As noted above, the combustion chamber was made shallower than the directions given in the circular. It is true that the oven was also made a little smaller than is called for in the circular, but it seems the change in dimensions was not proportional. The circular calls for a combustion chamber of two and one-half feet. The combustion chamber of the Cabano drier is only about 20 inches. The change in the dimensions of the oven is less than would be proportional. The effect is back firing, that is smoke coming out of the mouth of the oven, when a bulky fuel, like coconut husks, is used. The builders of the first college driers made a similar mistake. This is what happens: The smoke produced in the oven is too much for the chamber to dispose of, so it has to come back. But if the combustion chamber is two and one-half feet in size this will not occur. This has been shown in the construction of another drier. With the Cabano drier the back-firing can be avoided only by using shells as fuel. There is another thing in the Cabano drier which, though not a defect, is objectionable because of the expense incurred. The chimney built for the drier is expensive, but it will last a long time. I think a less expensive chimney would serve.

THE MEJIA DRIER

Contrary to previous arrangements, when I arrived in Puerto Bello, Leyte, I found that most of the materials needed were not ready. However, there were many odds and ends available at the hacienda which could be brought together and used in the construction of the drier. They had all the lumber necessary; also cement, sand and gravel required for the masonry work. They had no adobe stones but they had good clay. Several men were set to work making clay bricks. The process was to mix clay and fine sand in the proportion of seven to one. Water was added and the mixture put in molds the shape and size of a brick. To make the bricks hard they were put in a hydraulic press used for baling abaca. These bricks proved very good after they were baked. We used these bricks joined with cement in all masonry work, except in the oven, where we used red burned bricks bought in Cebu. In the other parts we used the same materials as those used in the Cabano drier.

The actual construction of the drier was not begun until September 18. After careful consideration Mr. Mejia, the owner of the hacienda, and I decided that it should be built in the sugar mill shed. There were two reasons for this decision: (1) The cost of a separate shed would be saved and (2) the chimney of the sugar mill could be used for the drier which meant considerable additional saving. The materials needed were ordered from Cebu. The following is the bill of materials of the Mejia drier.

TABLE 2

Bill of materials for the drier constructed at the Mejia Farm

5 pcs. iron plates, 4″×8″×1/8″	₱52.50
4 pcs. iron plates, 4″×8′×1/16″	48.00
6 pcs. angle iron bar	20.94
4 dozens sash rollers	36.00
Red bricks for oven 500 at ₱8.00 per 100	40.00
16 pcs. G. I. sheets No. 26 at ₱2.30	36.80
20 barrels cement at ₱7.50	97.50
25 meters wire screen, 1/4″ mesh, 20 gauge	69.82
Total	₱402.76

Materials used in the drier that were
not bought but were available on
Mr. Mejia's farm

Lumber

10 pcs. posts (molave), 4×6×4′
4 pcs. lauan, 2×6×20′
60 pcs. lauan, 1×2×14′
20 pcs. lauan, 1×12×12′
Sand
Gravel
Clay bricks (made by Mr. Mejia's laborer)
Nails
Other iron parts, as grating, door for oven, etc.

Approximate total cost	₱200.00
Labor and supervision	200.00
Grand total for Mr. Mejia's drier	₱802.76

NOTE:—This does not include the shed and no chimney was constructed.

The dimensions used were those found on page 14 table 1, column 3 of Circular No. 11. The dimensions of the chimney as required in the circular were not used as we used the chimney of the sugar mill. The construction of the heating chamber was very similar to the one in Cabano. Since the hacienda had better facilities for construction than the Cabano plantation we were able to construct a much stronger drier than the one at Cabano. Even the materials used were much stronger than those of the Cabano drier All the wood used in Cabano was of the third group. In the Mejia drier we used wood of the first group for the important parts.

The drier was finished on October 9, 1928; it took practically 18 days work. We tried it out on October 10. I taught the laborers how to run it; as it was simple they learned very easily. I left Puerto Bello the night of October 11, after good copra was produced and after I was sure that the laborers could manage the drier without assistance.

THE VILLEGAS DRIER

The drier in Tabon, Vallehermoso, Oriental Negros, was constructed in the "camarin" (shed) in the farm of Mr. Espiridion Villegas. At the time construction was begun, on October 13, Mr. Villegas had no material prepared, except a few barrels of cement, 10 sacks of lime, and several thousand red bricks taken from a ruined sugar mill. Sand and gravel could be secured on the seashore. On October 16, after the masonry work was under way, we went to Cebu to buy the other materials necessary. We were in Cebu for three days, as all the parts, even the simplest detail, had to be made there. Mr. Villegas had no facilities for construction on his hacienda.

The drier on Mr. Villegas' farm was a little different from either the Mejia or the Cabano drier. The people in the hacienda could separate the coconut meat from the shell even when fresh, hence the free-heater in the drier was not necessary. Besides, Mr. Villegas had a big bamboo platform which was in itself a free-heater (using sunshine for heat). In this case almost one-half of the drier was eliminated. The drier was 40 feet in length, 20 feet from the heating chamber and 20 feet from the free-heater. But to increase the capacity of the drier we increased the size of the heating chamber. Instead of making it only 20 feet we made it 30 feet, thus increasing the number of trays from 12 to 18. In all other respects this drier was the same as the Mejia. A little alteration in the dimension of the oven was made. Having found that the Mejia drier did not have a good draft though it produced the necessary heat, I tried another dimension on the oven. Instead of making it 3 feet wide and 3 feet deep, as stated in the circular, I made the width 2½ and the depth 3½ feet. With a chimney 18 inches in diameter and 30 feet high, it proved to make a much better draft than either the Mejia or the Cabano drier. The chimney was made of galvanized iron plates ordered in Cebu.

The Villegas drier is one that will last. It could not be made stronger. With red bricks for walls and other masonry work and using only first-class wood (molave in the major parts) the drier will see service for many years. Of course the masonry cannot be imitated in all places because of expense.

The materials used in the Villegas drier are listed below. In this list neither the bricks nor the molave posts, are included as they were obtained without cost from Mr. Villegas' farm. It will be seen that the total cost of the drier is somewhat high, considering the materials that are not included. This is so because, as can be seen from the prices below, the materials and labor in Cebu were very dear. It seemed to me that we were cheated. As an instance of the exorbitant price of materials in Cebu, we ordered a chimney of galvanized iron No. 24, 18 inches in diameter and 30 feet high, price ₱75.00. When the chimney came it was not very well made. Only nine sheets of the galvanized iron had been used. We calculated that the materials had cost about ₱25. At most it could have taken two men only one day to do the work, so for labor alone we were charged ₱50. It may be seen also that the cost of transporting the materials to Tabon was very high.

TABLE 3

Bill of materials of the Villegas drier

Iron plates screwed together to make a solid piece 6′×30′1/8″	₱132.00
Chimney of G. I. sheets, ordered in Cebu	75.00
Angle iron bar, 2″×2″×20′ with holes	27.78
6 dozens sash rollers	33.00
Screws for angle iron	0.35
3 pkg. screws for rollers	1.65
30 pieces crackets ordered in Cebu	3.00
38 wds.	15.10
113 feet wire screen, 1/4″ mesh, 20 gauge	91.40
1 roll wire No. 8	3.60
20 sheets G. I. No. 26	44.00
12 bolts, 1/2″×10″	2.40
40 nails, 6-inch	1.00
4 kgs. nails, 4-inch	0.80
3 kg. nails, 2-inch	0.60
10 kg. nails, 1-3/4 inch	2.00
10 kg. nails, 1-1/4 inch	2.00
30 ft. wire	1.00
Lumber—10 pcs. lauan, 1″×12″×18′	32.40
50 pcs. lauan, 1″×2″×14′	10.50
12 pcs. lauan, 2″×6″×12′	17.28
4 pcs. lauan, 1/2″×12″×18′	8.64
Freight for lumber	6.00
8 barrels cement	58.20
15 sacks lime	37.50
Transportation, cement	9.50
Transportation, lime	5.00
Transportation, wire	1.00
Transportation, iron plates	5.40
Transportation, angle iron	4.00
Total	₱632.80
Miscellaneous expenses connected with the construction of drier, including expenses of the College representative	121.30
Total cost of labor	177.17
Total expenses	₱931.27

Materials used that were not included in the list because they were available in the Hacienda

Sand
Gravel
Red clay bricks
Molave posts

The drier was finished on November 1, 1928, practically 18 days after it was begun. It was tried on November 2. It worked according to expectation. The desired draft was produced. Thus the best dimensions of the oven and the chimney were established. As at Mr. Mejia's farm the laborers were taught how to operate the drier, which they learned very easily. As Mr. Villegas is drying copra in the sun all the time, meat partially dried was obtainable. Copra was produced in a short time.

The drier has a loading capacity of 1,200. With this capacity it would be very easy to dry 4,000 to 5,000 nuts a day.

THE CABANO ESTATE

(GUIMARAS ISLAND)

History

The Cabano Coconut Estate is not a new agricultural colony. It has been under cultivation and there has been a settled community there ever since the Spanish time. It is said that it used to be composed of two colonies, one called Madrid and the other Barcelona. There are indications that it was once a rich community, as there now stand in Cabano monuments to indicate its past prosperity. At a point near the seashore there are the ruins of an old tower with a 10-foot cannon at its side. It is said that this was used as a defense against the invading Moro pirates which were common in those times in that part of the Archipelago.

The present Cabano Estate was formerly a property of the Montelibano family in Iloilo, but it was bought in 1917 by a Swiss corporation for ₱35,000. It used to contain 2,000 hectares, but about one-half of it was sold to another corporation and so the present Cabano Estate contains 1,008 hectares.

Crops and soil

The whole area is under cultivation. The major portion is planted to coconuts and the rest to rice and forage crops. The coconuts are planted in the higher areas. All the lower areas which cannot be planted to coconuts are planted to rice. A few hectares are reserved for pasture. There were at the time of visit 82,000 coconut trees on the whole hacienda. About 35,000 of them were bearing and the rest were from 2 to 7 years of age.

The soil of Cabano is fairly fertile. The lots near the seashore have the best soil, on which coconuts grow very well. They are comparable to the average plantation in Tayabas. The coconuts in the other lots are of the same type as the average Laguna coconuts. Rice grows well in the Hacienda.

Management and expenses

The hacienda is managed by administration. The manager, Mr. Vicente Villanueva (son-in-law of the late Mr. P. Zimmermann, one of the largest stockholders of the corporation), receives ₱100 a month with board and lodging. He is the manager and at the same time cashier and bookkeeper. He is assisted by a brother-in-law who receives ₱50 a month with board and lodging.

There are about 50 families on the hacienda. The workers receive 50 centavos a day and one ganta of palay. Every day the laborers are assigned to the different kinds of work in the hacienda, cleaning the plantation, gathering nuts, making copra, etc. Some of their houses are built in the different coconut lots, and the laborers serve as guards and inspectors of the lots which are near their homes.

The management of the hacienda has been very expensive. According to the manager the corporation has spent almost half a million pesos already on the hacienda. The returns from it are not very large. At the time of my visit the income was just a little over the operating expenses. However, it is on the increase. Every year more coconuts are bearing fruit. After five or ten years the great majority of the coconut trees will be in full bearing and there will be a considerable income.

The present problem

At present the hacienda is facing a big problem. Almost the whole coconut plantation is covered with cogon. As a consequence the majority of the coconut trees are not up to normal. Once an attempt was made to kill the cogon by plowing up the whole area. A large sum of money was spent on the work, but without good results. As is its habit, the cogon grew more vigorously after the plowing, so it still remains a menace to the plantation. The best they can do at present is to clean a space of about a meter in radius around each coconut tree. This has a slightly beneficial effect, but the harm the cogon does to the coconuts is still very marked. The estate is experimenting with *Tephrosia candida*. From results seen in other parts of the country, I believe that *Tephrosia* may solve the problem, but it will mean a heavy expense to cover the whole area with *Tephrosia*, and the corporation cannot afford it just now. So unless a cheap way can be found to control the cogon on the plantation, the bearing of the majority of the trees will be greatly retarded. Also the plantation is in constant danger of catching fire as the cogon is so easily ignited.

THE MEJIA HACIENDA

(LEYTE)

Unlike the Cabano Estate, the Mejia Hacienda claims no ancient history. It is a farm developed in the past sixteen years. Its history was begun and has been made by its owner and present manager, Mr. Teofilo Mejia. It is said that in 1912 the present site of the village known as Puerto Bello, in which the house of Mr. Mejia is located, was a *manglar* (swamp) and the rest of the hacienda was a forest. But now it is a very desirable place. It is considered the best and most beautiful hacienda in the Islands.

Area, soil and crops

The Mejia farm is about 2,000 hectares in area, all under cultivation. It is a completely diversified farm. The main crops are corn, coconut,rice, sugar cane and abaca. There is a ranch, a hog project, a poultry run and a pigeon loft. There are also many kinds of fruit and minor root crops. There are about 60,000 coconut trees, about 10,000 of which are bearing. The other 50,000 range from two to seven years old. The sugar cane plantation is about 20 hectares in extent. Mr. Mejia has a small sugar mill for making muscovado sugar. Rice is raised just for home consumption. Only a small quantity of abaca is raised. There are about 500 head of cattle, also some horses, and about 20 breeding sows (native and grade) At the time of my visit there were about 100 pigs in all. The poultry is raised only for home consumption.

The soil of the hacienda is for the most part fertile. Maize and coconut grow well in many parts. There are, however, lots that are very clayey and the crops are very poor. But, on the whole, the coconuts are comparable to the best in Laguna. The lots along the seashore are first class especially the one where the village is located and where there are about 10,000 trees bearing. Sugar and rice thrive fairly well on this hacienda.

Management.

The hacienda is managed partly by the administration and partly on the *kasama* (share) system. Mr. Mejia and his wife, his sons, and his daughters are the managers of the hacienda. The boys are given charge of some projects on the farm. One of them takes charge of the machinery and another of all the animals. The daughters are in charge of the store and the business part of the management. The father acts as the general manager or inspector. There are, however, nine employees in the hacienda known as *capataz* (overseers) who are assigned to different projects. Each project has a *capataz* with a certain group of men under him. There is a distinct division of labor. More than 150 laborers are employed every day. The wages range from 30 to 50 centavos a day with meals. The *capataz* receives a little higher pay. The workers under the *kasama* system have a contract with the landlord similar to the *kasama* in Laguna and Tayabas. They are given work animals and a piece of land to cultivate and get two-thirds of all the harvest from the land, provided they plant coconuts for the landlord on the land cultivated.

The present management of the hacienda is excellent. It could not be better. Everything is done systematically and in a very orderly manner. The *capataz* have been so trained in their assignments that very little instruction is necessary. The work of the managers is practically only inspection. Complete records are kept.

Equipment and facilities

The hacienda is very well equipped with modern machinery and other conveniences. There is an electric plant and water system; railroads and wagons for transportation of the crops from the farm to the wharf; a good drainage system of open canals; a shop with facilities for repairing machinery and other iron work, and for almost all kinds of construction work; a hydraulic press and several corn shellers; and a mill for making muscovado sugar. All these contribute to the efficiency of the hacienda.

Income

The hacienda has an income of about ₱30,000 a year. This comes mainly from corn. But five years from now the income should be very much increased as the majority of the coconut trees should be in full bearing. At present only 10,000 of the trees are bearing. The other sources of income are sugar cane, abaca, and minor crops. Another succesful enterprise is the store, a large one, in the hacienda where almost all necessary commodities are sold. The daily sales amount to 10 to 50 pesos on week days and 500 to 1,500 pesos on Sundays.

The development of the hacienda

It may be of interest to know how this beautiful hacienda reached its present state. Mr. Mejia started with relatively small capital, only about ₱5,000. It seems unbelievable that from such a comparatively small amount he has been able to develop in sixteen years an hacienda now worth about ₱2,000,000. Certain conditions of the location are partly responsible. Corn grows well and the market and the price in Cebu are good most of the time. The cost of production is low and, in a fertile place like Ormoc two full crops can be grown each year. Corn is a much better crop than rice. All the money from the corn crop is spent in improvements on the hacienda. Mr. Mejia has grown corn while planting coconuts, thus from the start he has been able to develop his farm out of its own resources. Even if he has no cash on hand he has wealth. He told me that he had encountered many difficulties; but he is not a "quitter", and patience is one of his virtues. He has stuck to his work for sixteen years and now he is harvesting the fruit of his labors.

Farm practices

On the Mejia hacienda there are practices not very common in coconut haciendas in Luzon. In the coconut plantations are trees marked with the letter "S" denoting *semilla* (seed). This means that these trees are sources of seeds for planting. The nuts harvested from them are not made into copra, but are put in the seed bed. This is seed selection. I noticed that the majority of the trees marked with "S" are the colored nuts, nuts which we call *kalimbahin*. Mr. Mejia claims that the colored nut is much better than the common nut. This seems to be the case at least in his hacienda. The trees produce fruit earlier and more abundantly than the common nuts. They are also less often attacked by beetles. It is likewise the practice in the hacienda to clean the coconut trees at least once a year of dried leaves and dried stuff around the bud. Mr. Mejia claims that these dried parts harbor insects that destroy or prevent the formation of more flowers. This seems to be another good practice which is followed on the 10,000 trees now bearing in the hacienda. But when the number of bearing trees becomes, say, 50,000 it will be expensive and it may be a problem to keep up the practice. In most cases, the coconut plantation is cultivated. Similar to the practice in the Calamba Sugar Estate coconut project in Laguna, Mr. Mejia maintains a strict campaign against the the Asiatic palm weevils. He pays one centavo for every weevil caught on the hacienda.

Social and sanitary conditions

With very few exceptions social and sanitary conditions in big haciendas in the Philippines are not very good. Among the exceptions is the Mejia hacienda. The laborers there live in a comparatively decent way under good sanitary and hygienic conditions. Mr. Mejia is an apostle of cleanliness. As he has a good supply of water he built several public baths for his laborers. There is plenty of water for washing clothes. As has been said the drainage system of the hacienda is so effective that there is not a drop of stagnant water on it. He requires that the yards and surroundings of the houses of his laborers be kept clean and sets the example himself.

The laborers are healthy and appear very well contented. They lead a comparatively easy life, considering that they are on an hacienda. They are not treated as serfs, as they often are on sugar and rice haciendas. A laborer can choose between two things. He can either be a *kasama* or *peon* (day laborer) of the hacienda. If he is a *kasama* he enters into a contract with the landlord. If he becomes a *peon* he can earn from 30 to 50 centavos a day with meals. Even his wife and children can work in the various projects in the hacienda. All those living on the hacienda (*kasama* or *peon*) are free to plant vegetables and other quick growing crops in their yards without any share for the landlord. They are also free to own hogs and chickens provided they raise them well and keep them clean. Fish abound in places near the hacienda.

One can see the ease of life in this hacienda on Sundays. Puerto Bello is a barrio trade center. Early in the morning people come from different parts of the hacienda with something for sale, such as camotes, bananas, fruit of all kinds, fish, chickens, etc. They assemble in a sort of market place where there are all kinds of things to eat. People from distant barrios come to this place to trade and to indulge in gambling, which is permitted on Sundays. There are policemen, but they only watch for those who make trouble. There is a cockpit. Mr. Mejia's idea is that vices, such as gambling, cannot be prohibited, but they can be regulated. He says that allowing them one day a week for such indulgence is not bad. He claims that formerly when he did not allow them to gamble on Sundays they indulged in it on week days. Now he permits it on Sundays but absolutely prohibits it on week days. This scheme seems to work on his hacienda. For those who do not indulge in gambling he provides a free movie on Saturday and Sunday nights.

THE VILLEGAS HACIENDA

(ORIENTAL NEGROS)

History

This hacienda was started by Mr. Villegas thirty-five years ago. It was practically a forest covered with first class lumber trees when Mr. Villegas took possession of the land. The first class lumber was so abundant that it was not necessary for Mr. Villegas to buy any lumber when he built his present house, which is a large one worth about ₱50,000. It is of interest to mention in passing that in making excavations for posts for this house the laborers found bones of human beings and under those bones were old Chinese porcelain vases and other ware. As they dug further they found a good collection of these historic articles. It is said that even Dean C. Worcester, then Secretary of Interior, went there at one time to make excavations and was able to get a collection of valuable relics. The place is now called Tabon because when Mr. Villegas first came there were many birds known as *tabon* (moor-hen).

Area, soil and crops

The Villegas hacienda has an area of 1,364 hectares. Four hundred hectares are covered with coconuts. There are in all about 35,000 trees. About 22,000 of them are in production, and about 13,000 are from 1 to 5 years of age. About 250 hectares are planted to corn. A few hectares are planted to rice for home consumption. The rest of the land is forest and cogonal.

The soil of Tabon is fairly fertile. It is a little better than the soil in Cabano but not as fertile as that of Puerto Bello. The coconuts compared favorably with the average nuts in Tayabas. Corn grows fairly well, though not so vigorously as in Leyte.

Management

The hacienda, like the Mejia hacienda, is managed partly by the administration and partly by the *kasama* system. The manager is Mr. Villegas, assisted by his wife. They have assistants helping them. There is a bookkeeper and several *capatazes*, or *cabos*, as they call them. The *cabos* are assigned to the different projects. They receive direct instruction every day from Mr. Villegas. There are five *cabos* for the corn project, two for cleaning the coconut plantation, one for hauling the nuts, and one for making copra. There is an inspector of the coconuts and a night watchman.

Different rates of wages are paid the different laborers. The *cabos* receive with food ₱10.00 a month; laborers (men) ₱2.00 a week; women ₱1.20 to ₱1.50 a week; and boys from ₱1.00 to ₱1.20 a week. The hacienda employees earn from ₱0.80 to ₱1.00 a day.

The *kasama* has this contract with Mr. Villegas: He is assigned a piece of land and gets all the produce from that piece of land for four years. Mr. Villegas plants coconuts on the land which is cleaned at his expense. He gets nothing from the *kasama*. His only object is to have the land cleaned.

Income

The main income of the hacienda is derived from coconuts in the form of copra. Table 4 shows the copra production in the hacienda since 1917.

There are no exact figures for the income from corn so they are not included here. A great part of the corn is eaten on the hacienda.

The problem

The main problem on the hacienda is drying copra. Before the drier was built all the copra was sun dried. With the number of coconut trees bearing on the hacienda (22,000) the copra could not be dried as fast as the nuts ripened. The process was so slow that they were usually a month behind. This delay caused the nuts in the pile to germinate before they could be dried. This meant a great loss, because once the nuts have germinated about 30 per cent of the oil has been lost. Besides, the drying of copra by sun is very tedious and uncertain. Too much labor is required and so the work becomes very expensive. The drier will help partially to prevent this loss; to prevent it entirely two or more driers are needed.

TABLE 4

Copra production on the Villegas' farm

YEAR	NUMBER OF PICULS	VALUE	EXPENSES
		Pesos	*Pesos*
1917	822.37	8,208.54	857.56
1918	1,092.25	12,620.83	728.36
1919	1,042.35	18,846.16	708.45
1920	1,008.47	21,397.44	1,360.57
1921	1,560.05	15,182.56	1,434.22
1922	1,692.60	18,340.38	1,465.92
1923	1,995.79	22,265.81	1,350.81
1924	2,015.00	26,753.17	1,488.16
1925	1,890.30	26,931.58	5,289.74
1926	2,696.20	38,097.65	3,555.50
1927	2,311.78	27,378.31	3,793.11

For the year 1928 for eight months

		Pesos	*Pesos*
March	289.67	3,512.24	40.70
April	None	———	———
May	421.00	5,316.18	487.50
June	None	———	———
July	381.56	4,387.94	489.30
August	474.11	5,155.94	593.22
September	None	———	———
October	408.40	4,441.35	567.40

NOTE:—These data were furnished by the bookkeeper of the hacienda.

THE COURSE IN AGRICULTURAL EDUCATION AND THE COLLEGE RURAL HIGH SCHOOL

A course in agricultural education, leading to the Certificate in Agricultural Education, has became available at the College of Agriculture beginning the summer term of 1929. Completion of the second year basic course in the College of Agriculture, or its equivalent, or graduation from the B.Agr. course, is required as prerequisite for these courses. This plan requires a total of five years of college work. Students candidate for the Certificate in Agricultural Education must have completed all the courses required for the degree of B. S. Agr. as given in the College of Agriculture or its equivalent, including credits in the following courses:

Agricultural Education 1	Elementary Methods	3 Units
Agricultural Education 2	Elementary Psychology	3 Units
Agricultural Education 3	History of Education	2 Units
Agricultural Education 4	Educational Statistics	2 Units
Agricultural Education 5	Rural Education or	3 Units
Agricultural Education 6	Educational and Rural Sociology	(3) Units
	Total	13 Units

The curriculum consists of one-year schedule of collegiate work.

As a training school, the Department of Agricultural Education is opening the College Rural High School on June 1, 1929. The first two years of secondary work will be offered during the school year 1929–1930. Applicants for admission in the first year must be graduates of intermediate schools who have a final grade of at least 75 per cent in English and Arithmetic. Students who have satisfactorily completed the first year of approved agricultural or rural high schools may be admitted to the second year. Entrance is by application only.

Applications for admission to either the course in agricultural education or to the College Rural High School should be sent to the head, Department of Agricultural Education, Agricultural College, Laguna, P. I.

A PRELIMINARY STUDY OF THE LIFE HISTORY AND HABITS OF KANDULI (ARIUS SPP.) IN LAGUNA DE BAY[1]

ANDRES M. MANE

WITH ONE PLATE AND SEVEN CHARTS

INTRODUCTION

The kanduli (*Arius* spp.) are catfishes which belong to the family Ariidae of the order Nemathognathi. They are found both in fresh and in salt water in the Philippines. In Laguna de Bay, a fresh-water lake of Luzon, Philippine Islands, the area of which is about 346 square statute miles, the kanduli are found in great abundance and are taken in almost all portions of the lake.

There are now known in Laguna de Bay at least twenty species of food fishes which are generally caught in commercial quantities. Of these, kanduli are the most abundant and most widely used as food by the native inhabitants of Laguna, Rizal, and the neighboring provinces.

The most recent estimate of the value[2] of the fresh-water fisheries of Laguna de Bay is made by the Bureau of Commerce and Industry and is placed at half a million pesos annually. Fishermen and municipal and provincial officials in regions bordering the lake estimate that at least two-thirds of this amount are derived from the kanduli fisheries alone. The writer, who has made extensive observations on the fisheries of Laguna and Rizal provinces, concurs in this opinion.

Further indicative of the importance of the kanduli fisheries of Laguna de Bay is the fact that the most important and most numerous fishing gears and devices are constructed to catch this fish. Among these devices may be mentioned the *pukot* (seines), *baclad* (fish corrals), *pante* (gill, or drift, nets), and *kitang* (set lines with baited hooks).

Time and place of the present work

The work was begun in July, 1927, and closed in January, 1929. Field observations and collection of samples were mostly made in Calamba, Laguna. Frequent trips to the more important fishing centers and fishing

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[1] Thesis presented for graduation, 1929, with the degree of Bachelor of Agriculture, from the College of Agriculture No. 292. Experiment Station contribution No. 607. Prepared in the Department of Entomology under the direction of Assistant Professor Deogracias V. Villadolid.

[2] In a letter, under date of October 18, 1928, from the Director, Bureau of Commerce and Industry, to Dr. Villadolid.

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banks in Laguna and Rizal provinces were made for the purpose of securing information, both from fishermen and by personal observation, regarding the migratory movements and other habits of the fish.

Laboratory studies were carried on in the Department of Entomology, College of Agriculture, Los Baños.

Objects of the present work

The objects of the present work were (a) to follow the development and determine the rate of growth of the ova (eggs) of *Arius* in order to ascertain the exact spawning period of the fish; (b) to determine the duration of the spawning season; (c) to determine the "age groups" of the fish at sexual maturity, as well as the "age groups" composing the catches of the *pukot* hauls; (d) to make observations on the movements of the fish in Laguna de Bay; and (e) to determine the food constituents of the fish by examination of stomach contents.

Review of the literature

References relating to the study of the habits of catfishes in the Philippines are conspicuous by their absence. Herre (1926) deals only with the systematic considerations of the order Nemathognathi of the Philippines. He observes, among other things, that six species of Ariidae are found in Laguna de Bay. They are: *Arius goniapsis* Bleeker, *A. dispar* Herre, *A. manillensis* Cuvier et Valenciennes, *A. thalassinus* (Ruppel), and *Hemipemelodus manillensis* (Cuvier et Valenciennes). Of these species, he reports that *Arius manillensis* is the most abundant. This statement is corroborated in the present investigation. In fact in the course of the present study, the writer found that the commercial catches of kanduli in Laguna de Bay during the years 1927 and 1928 were mostly composed of *A. manillensis*, and the scarcity of other species in the catch was well marked.

In the United States, most of the published reports on the habits of the catfishes were based upon observations made under artificial conditions (fishes reared in aquaria). Some of these reports are reviewed in the present paper, inasmuch as the species observed are closely allied to the Philippine species of Ariidae.

Ryder (1893) described the breeding process of a pair of Potomac channel catfishes (*Ameiurus albidus* Le Sueur) reared in the aquarium in Washington. He made mention of some of the more interesting phases of the development of *A. albidus*. His report has been summarized by Kendall (1912) as follows:

> On the morning of the 13th of July, a little after 10:00 o'clock, we noticed a mass of whitish eggs in one of our aquaria inhabited by three adult specimens of *Ameiurus albidus*, two of which were unmistakably the parents of the brood, for the reason that they did not permit the third one to approach near the mass of eggs, which one of them was watching vigilantly. One of the individuals remained constantly over the eggs, agitating the water over them with its anal, ventral, and pectoral fins. This one subsequently proved to be the

> male, not the female, as was at first supposed. The female, after the eggs were laid, seemed to take no further interest in them, the whole duty of renewing and forcing the water through the mass of adherent ova devolving upon the male, who was most assiduous in this duty until the young had escaped from the egg membranes. During all this time, or about a week, the male was never seen to abandon his post, nor did it seem that he much cared even afterwards to leave the scene where he had so faithfully labored to bring forth from the eggs the brood left in his charge by his apparently careless spouse. The male measured 15 inches in length, the female one-fourth inch more.
>
> The mass of ova deposited by the female in a corner and at one end of the slate bottom of the aquarium measured about 8 inches in length and 4 inches in width, and was nowhere much over one-half to three-fourths of an inch in thickness. The ova were covered over with an adhesive, but not gelatinous, outer envelope, so that they were adherent to the bottom of the aquarium and to each other where their spherical surfaces came in contact, and consequently had intervening spaces for the free passage of water, such as would be found in a submerged pile of shot or other spherical bodies. It was evident that the male was forcing fresh water through this mass by hovering its fins rapidly. There were probably 2,000 ova in the whole mass, as nearly as could be estimated. All of these left in the care of the male came out, while one-half of the mass which he had detached from the bottom of the aquarium on the third day, during some of his vigorous efforts at changing the water, were transferred to another aquarium, supplied with running water, and left to themselves. Those which were hatched by the artificial means just described did not come out as well as those under natural conditions. Nearly one-half failed to hatch, apparently because they were not agitated so as to force fresh water among them and were not kept clean by the attention of the male parent. When first hatched, from the sixth to eight day, the young exhibited a tendency to break up or school together like the young salmon. They also, like young salmon, tended to face or swim against the current in the aquarium, a habit common, in fact, to most young fishes recently hatched.

Smith and Harron (1902) reported similar observation on the habits of a close relative, *Ameiurus nebulosus* Le Sueur. Among other things which they observed was the very curious behavior of the parent fish in the care of their eggs. Quoting the authors:

> Both parents were very zealous in caring for the eggs, keeping them agitated constantly by a gentle fanning motion of the lower fins. The most striking act in the care of the eggs was the sucking of the egg masses into the mouth and then blowing them out with some force. The fanning and mouthing operations were continued with the fry, until they swam freely, when the care of the young may be said to have ceased.

Kendall (1910), working on the habits of some commercial catfishes of the fresh waters of the United States, considered the group a hardy race, very prolific, and comparatively safe from enemies . He further stated that almost any one of the species seems to be adapted to a wide range of climatic conditions, although somewhat restricted in certain immediate surroundings, and that the possibility of rearing them in artificial ponds or in ponds unsuited for other fishes is very great.

Ryder (1883) mentioned the fact that that species of *Arius* have the habit of carrying ova in the hind part of the oral cavity or branchial region until the young are hatched. This habit was also mentioned by Turner (cited by Ryder, 1883).

MATERIALS AND METHODS

Field studies

a. Collection of materials. The collection of materials for study was largely made in Calamba, Laguna. The town is one of the most important fishing and marketing centers on the shores of Laguna de Bay. A large portion of the catches taken from the waters of Laguna de Bay is marketed in this town.

Oftentimes, collections of samples were made from the *pukot* hauls. It was, therefore, necessary for the writer to accompany fish vendors on their trips to the fishing grounds.

b. Sampling. Efforts were made to obtain representative samples. It was possible for the writer to secure samples representing fishes belonging to the different "age groups" present in the catch, because *pukot* is a non-selective fishing gear, hence, it catches fish from the smallest to the largest size.

c. Determination of length frequencies. As the work needs a large number of fish, measurements were made in the fishing vessels just after the catch was transferred from the *pukot* nets. The fish were examined on the deck as they were brought in. The measurements were made by laying a steel millimeter tape along the side of the fish from the snout to the end of the caudal vertebrae.

d. Observations on the movements of the fish. Observations as to migratory habits were made from time to time in the lake. Information was gathered from experienced *pukot* fishermen during the trips to the fishing banks. Catches of the different fishing devices on different portions of the lake were examined. The relative abundance and composition of each catch were noted.

Laboratory studies

a. Studies of the ova. Ova which did not exceed 0.98 millimeter in diameter were measured with the aid of a compound microscope which was fitted with an eyepiece micrometer. The diameter was determined by placing horizontally the eyepiece micrometer across the field of the microscope and then reading the diameter of the egg across the widest portion. Clark (1925) in her work on the ova of *Leuresthes tenuis* Ayres measured the longest and shortest diameters of about two thousand ova, and the average of the two determinations was taken as the true diameter. The eggs used in the test were obtained from the anterior and posterior portions of the gonads. On comparison of the curves resulting from the two measurements, she found that the curves did not differ. It was, therefore, deemed safe to measure along one axis only.

For ova exceeding 0.98 millimeter in diameter, measurements were made by means of a micrometer caliper graduated to 0.01 millimeter. A portion of the ovary from each individual fish was teased on a slide and measurements made on all ova until the desired number was reached.

b. Study on sexual maturity. In determining the sexual maturity of the fish, a series of dissections representing different sizes of fish during the breeding season was made. The condition of the gonads was ascertained and the sex was likewise determined.

c. Observations on the food habits of the fish. Determination of the monthly range of the food of the kanduli was made by examining the contents of 288 stomachs. The relative abundance of the various food constituents was estimated by bulk and their percentages computed for each individual.

RESULTS AND DISCUSSION

History of the ova

a. Condition of the ova during pre-spawning season. The history of the ova was followed from the earliest recognizable formation of a new generation of eggs up to the spawning period. Collections and measurements were begun soon after the breeding season of the fish, so as to be reasonably sure that the eggs studied represented a new generation. The ovary during the prespawning season is flaccid with walls collapsed, and is not sufficiently bulky to fill the abdominal cavity posterior to the stomach, a condition which is sharply in contrast with that in the spawning season, when this organ fills the entire cavity at that region, is very turgid, and the walls thin, widely stretched and very vascular.

Chart 1 shows the frequency polygons of the diameters of ova measured at weekly intervals from fish collected during the five-month period from September 11, 1927, to February 12, 1928. The measurements were made between these dates because new generations of eggs begin to appear in the ovaries about September, reaching maturity about February. Each curve is the result of measurements of 300 ova taken from 10 fish collected at random at any given time.

The series of measurements made from September 11, to October 15, showed that the eggs measured from 0.08 mm. to 2.00 mm. in diameter. The upper size limit of 2.00 mm. diameter is fairly uniform and is multimodal. These eggs are grouped under *immature class* (group I eggs). Since this group of eggs has been observed to be present throughout the year, any increase in size beyond this dimension may be regarded as an indication of growth toward maturity.

The beginning of growth first became manifest among the ova collected on October 24. Of the ten fish collected, one had ovaries which contained eggs exceeding a size group of 2.00 mm. diameter. Collection at subsequent dates showed a steady progressive growth of ova, until a diameter with an upper size limit of 3.50 mm. was reached in the collection of December 25.

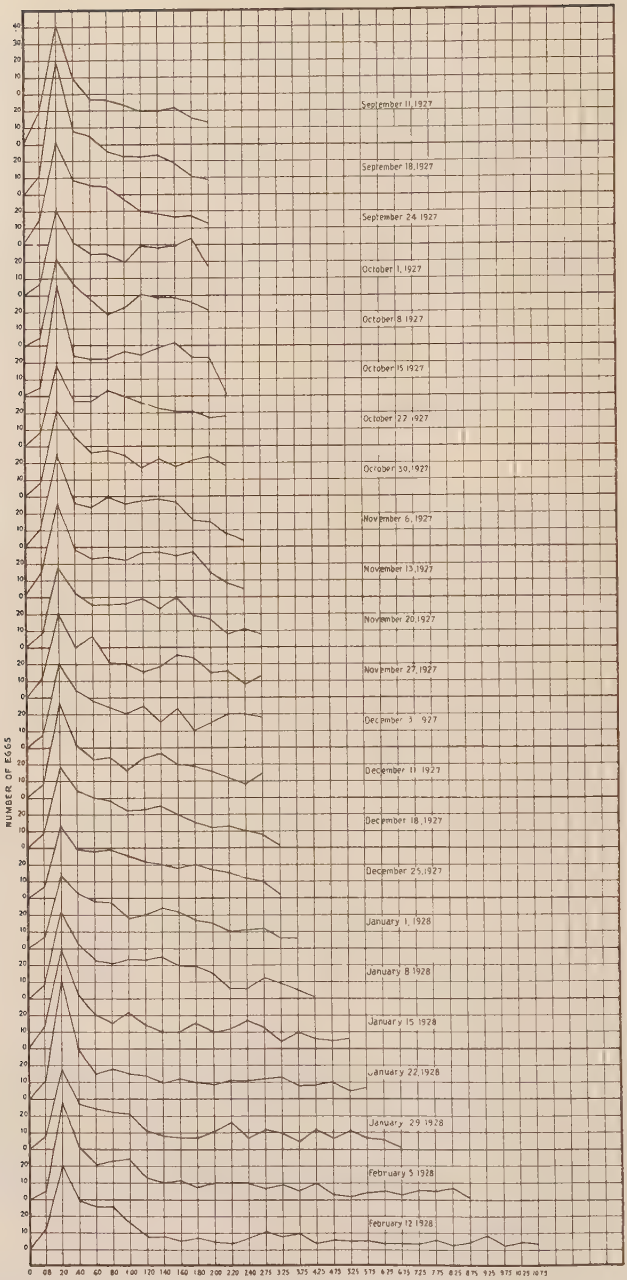

Chart 1.—Frequency polygons of diameters of ova during pre-spawning season, September 11, 1927, to February 12, 1928.

The ova which measured from 2.00 to 3.50 mm. in diameter have been grouped under *intermediate class* (group II eggs).

The immature, or group I, eggs were very light creamy white, stippled with tiny black chromatophores. The intermediate class eggs (group II) were also creamy white but with the black chromatophores more prominent. However, upon reaching their upper diameter limit of 3.50 mm., a distinct change to an orange color took place. This orange color persisted and became deeper in shade as the eggs reached maturity, when they measured from 5.50 to 10.75 mm. in diameter.

The collection on January 1, 1928, showed the presence in the ovaries of the maturing class of eggs (beginning of group III eggs). Beginning at this time there was a rapid growth in the ova which continued to increase until February 12, when the eggs reached an upper diameter limit of 10.75 mm. In this size group (group III), the eggs were apparently ripe and ready to be expelled.

The rate of growth of ova during the pre-spawning period may be summarized as follows:

(1) The ova which were classified under the *immature class* (group I eggs) measured from 0.08 mm. to 2.00 mm. in diameter. It took about five months for the new generation of eggs to reach the diameter limit of 2.00 mm.

(2) The ova that were classified under *intermediate class* (group II eggs) measured from 2.00 to 3.50 mm. in diameter. It took about two and a half months for this class of eggs to reach their diameter limit of 3.50 mm. These eggs were first observed to appear in the ovaries of the fish about October 15, 1927; they continued to grow until December 25, 1927, when the transition period from group II eggs to group III eggs was reached.

(3) Group III eggs, or those included under the *maturing class*, measured from 3.50 to 10.75 mm. in diameter. It took about one and a half months for the eggs to develop from the transition period between groups II and III to the point of maturity. This class of eggs was noted in the collection made on January 1, 1928, and on February 12, 1928, the appearance of the mature ova was noted.

The simultaneous presence of the three classes of ova in the ovary during the breeding season was found in the kanduli. Apparently, this condition is true in many species of fish. Clark (1925) found the same condition obtaining in the ovary of *Leuresthes tenuis* during the breeding season of that fish. Calderwood, cited by Clark (1925), says that "minute," "small," and "great," ova corresponding to my *immature*, *intermediate*, and *maturing ova*, respectively, are generally found simultaneously in the ovaries of many species of fish. He considers the great ova to be spawned during spawning season, the smaller ones, a year after, and the minute ones in the succeeding years. Thompson (1914) also showed three generations of ova in the halibut and called them *ripe ova*, *ova for the next season*, *and* *ova for the succeeding seasons.* The smallest ova in reality comprise a composite group of a number of successive generations.

b. Spawning habits and conditions of ova during the breeding season. It is an accepted belief among Laguna fishermen that the kanduli gather in schools at the approach and during the breeding seasons. Experienced fishermen claim that the whereabouts of the schools of fish may be detected by the presence of a group of white birds, called *kanaway*, *Hydrochelidon hybrida* (Pallas), which have the habit of hovering over and swooping into the water to catch fish. These birds are believed to be attracted by the odor of mucous secretion of the fish. Frequent observations have shown that the fish in schools come near the surface during their feeding activities. These birds follow the movements of the fish as long as they are able to detect their presence.

That the kanduli gather in schools during the breeding season is an assumption which likewise finds indirect support on evidence from repeated field observations. In the first place, the eggs, soon after being spawned and fertilized are transferred into the mouths of the males for incubation and protection. In the second place, it has been repeatedly observed under field conditions that the catches taken from *pukot* hauls made at any time during the breeding season are mostly composed of spent females and males. The males had newly spawned eggs in their mouths.

The manner in which the eggs are taken into the mouth of the males has not been determined. There is a possibility that the eggs hang onto the ventral fins of the female from which they are picked off by the males. This suggestion is based on the fact that during the breeding season, cartilaginous enlargement is developed in each ventral fin of the mature female fish. This structure is derived from the first fin ray of the ventral fin, counting from the mesoventral side (plate 1, fig. 2). Lending further support to this view is the fact that some spawning fish caught in nets and brought up suddenly were seen in the act of extending their ventral fins where eggs were momentarily held and then quickly dropped into the water by the excited females.

In the collections made on February 17, ova belonging to group III were no longer present in the ovaries of eight out of the ten fish examined. In other words, eight of them were already spent. They had ova which were slightly larger than those of the *iniermediate class.* During this period, (week ending February 17) fishermen reported that the kanduli were observed to congregate in schools, and the writer, for the first time that year, found among the catches mature males carrying eggs in their mouths. This period was taken to be the beginning of the spawning season. Subsequent collections showed the presence of maturing eggs in the ovaries of the fish examined.

In chart 2, it is evident that active transformation of intermediate eggs into maturing ova was taking place in the ovaries of the fish. This condi-

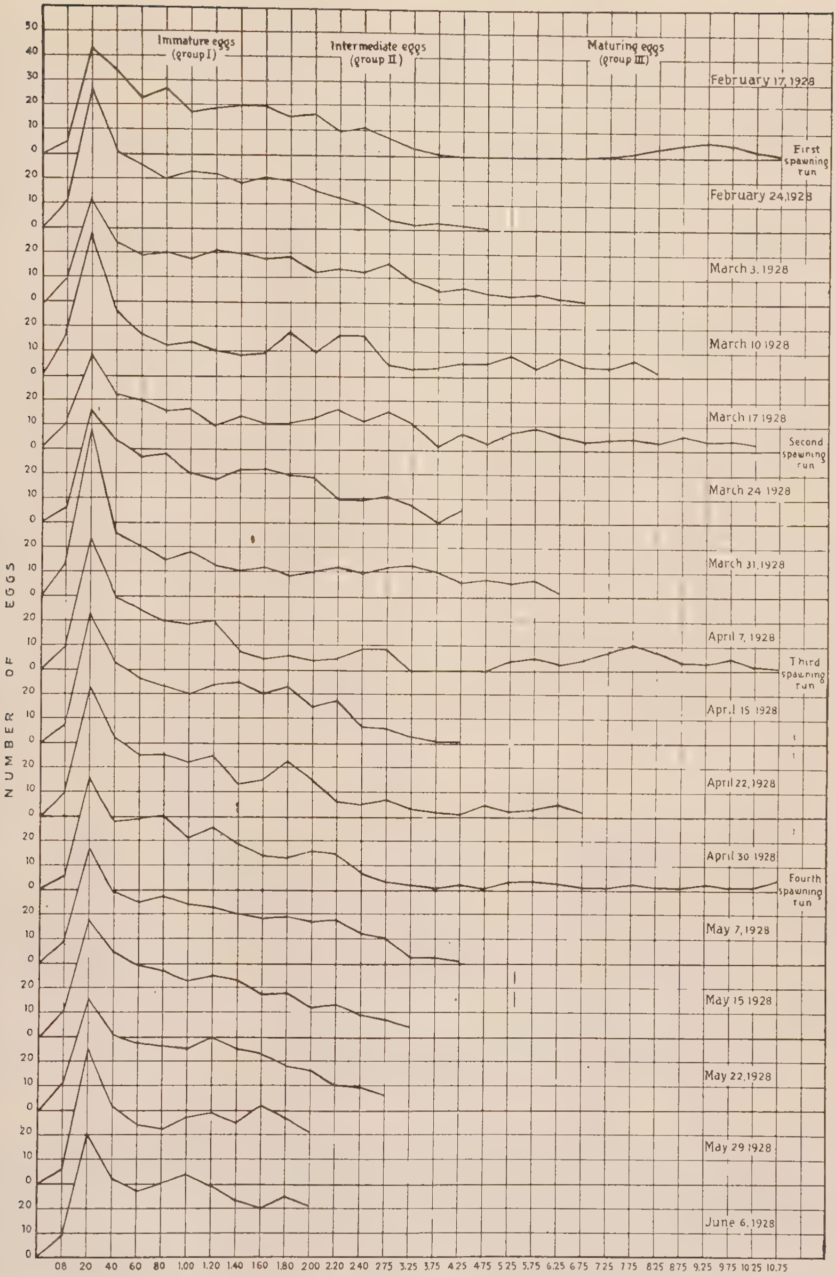

Chart 2.—Frequency polygons of diameters of ova during and after spawning season, February 17, to June 6, 1928.

tion was ascertained by determining the proportion of intermediate to maturing ova. Samples of ovaries were taken from collections of fish made at different times during the breeding season. A section two centimeters thick was cut from the middle portion of the ovary and separate counts made of the intermediate and of the maturing ova. On February 17, the ratio of the maturing ova to the intermediate was 1:12.5; this ratio decreased gradually as the spawning season approached its end until on May 10, or less than three months later, when the ratio was found to be only 1:2.6. Table 3 shows the results of the determinations of the ratios of the maturing eggs to the intermediate eggs made during the spawning season.

At the end of the spawning season, around the middle of May, no maturing eggs could be found in the ovaries of any of the many fish examined. There were, however, some intermediate eggs which were apparently undergoing degeneration (pl. 1, fig. 6). These ova probably represented a part of those spawned during the breeding season, which had failed to reach maturity at that time through certain causes. This phenomenon has been reported in connection with other fish species. Clark (1925) records having found degenerating ova in spent *Leuresthes tenuis*, and suggests that resorption of aborted eggs in the spent ovaries might have been accomplished by the tearing down of the follicle cells.

Cunningham, cited by Clark (1925), believes that the cells which took part in the degeneration of eggs in *Trigla hirundo* Girard are derived from the connective tissue of the walls and not from the folliculer epithelia of the ovaries.

Spawning and breeding habits of kanduli

As stated above, the first appearance of spent fish was noted during the week ending February 17, 1928. Maturing eggs were found undergoing rapid development in the collections of eggs made on February 24, March 3, and March 10. On March 17, the ovaries examined contained mature ova (group III eggs). On March 24, there was a marked absence of mature ova, and interpretation was made that the fish must have spawned during a period between March 17, and March 24. However, on March 31, there were found some fish carrying maturing ova and on April 17, the eggs were found to have reached their upper size limits and therefore were ready to be spawned.

On April 25, another batch of maturing eggs developed and were spawned about the first week in May. After this time, no maturing ova appeared in the ovaries, and the weekly collections made from May 7 to May 24 failed to show maturing ova; intermediate eggs which were undergoing degeneration were found instead. In the collection of June 1 to June 8 the degenerating intermediate ova disappeared entirely from the ovaries, and only the immature eggs (group I eggs) were found.

Chart 2 shows this series of changes in the development of the ova of the kanduli from February 17, 1928, to June 6, 1928.

From the foregoing discussion it may be inferred that the fish has four spawning runs during the breeding season, the first one occurring about the middle of February, the second about the middle of March, the third about the middle of April, and the fourth about the first week of May[4]. The explanation that may be advanced to account for the limitation into four spawning runs of the kanduli during the breeding season is that the mother fish is probably unable to furnish adequate nutrition for a greater number. Another, though minor, explanation is that the body cavity of the kanduli is not roomy enough to accommodate large ovaries which can hold many eggs, considering the size of the ova of the fish—a mature ovum measuring over a centimeter in diameter. In that event, should the fish spawn but once in the breeding season, its rate of multiplication would be very limited.

In an effort to determine the period during which the spawning activity was at its peak, samples of mature fish were teken from the catch of *baclad* at weekly intervals from March to May, 1928. The number of kanduli that carried eggs and larvae in the mouth and those that did not have any were counted. The results of these determinations are given in table 7.

It will be noted that in February, only 15.48 per cent of the total number examined had eggs in their mouths; in March, 24.92 per cent: in April, 32.63 per cent; and in May, 13.89 per cent. The highest peak of spawning activity must have taken place, therefore, some time in April, which was covered by the third spawning run.

The brooding period may be taken from the time the males take the eggs in their mouths to the time young fish are liberated. It has been observed that the young kanduli are set free at the time when the stored yolky material has been completely used up. At this period, they are able to swim actively. From a series of measurements, these newly liberated young fish were found to range from 3.0 to 4.4 centimeters in length. The first appearance of the male fish carrying eggs in their mouths was observed on February 12, 1928. The young larvae were first observed to have been freed on April 10. The brooding period of the kanduli, therefore, must cover a period of about two months.

Attempts were made to confirm the presumption that the males are the only parents that take care of the broods. Accordingly, samples of brooding fish were collected during the breeding season, and their sex determined by dissection. The number of eggs or larvae found in their mouths was also noted.

It is to be noted from table 4 that only one fish, out of 249 examined, was a female; all the rest were males. The single exception is probably unusual.

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[4] Consult chart 2 for diagrammatic details.

Age groups of kanduli present in the commercial catch of the pukoi hauls

Pukot, being a non-selective fishing gear, catches fish of all sizes found in the fishing grounds. By analyzing the composition of catch of this fish trap, it is possible to obtain samples which when measured and distributed in frequency curves in accordance with standard statistical methods, will form natural groups under separate modes. Each of these modal groups may be taken as an *age group*. In this way, it is possible to obtain a close approximation of the size of the fish under different age groups present in a given body of water.

In the present work, the age group method is used in determining the rate of growth of the kanduli. It consists of ascertaining the average length of each of the age groups present in the catch. Such averages were obtained by measuring a large number of individuals of various sizes obtained from any given haul of the *pukot* and then representing these measurements in the form of frequency polygons. From these curves the age groups were identified as shown by their modes.

The writer is aware of the fact that the age group method can not produce accurate results in the case of very old fish. However, it appears to be satisfactory in defining the first, second, third, fourth, fifth, and sixth age groups, which are the only ones necessary in this work, considering the fact that the kanduli has been found to be sexually mature upon reaching the second age group.

Many investigators in temperate countries have resorted to the "annual ring" method, for, as a rule, the annual increment of fishes is marked in the scales, earbones (otoliths), vertebrae, and other osseous parts. But in a tropical region, like the Philippines, the kanduli and other species of fish entirely lack well defined annual rings in their osseous skeleton.

In addition, the age-groups method is feasible in cases where large numbers of measurements can be made for statistical treatment. In Laguna de Bay, where this work was carried on, material in adequate number is available for study.

a. Growth of young kanduli. The first indication of the presence of spawned ova in the mouths of the males was observed in the present experiments on February 12, 1928. The first collection of young fish used in growth determination was made on June 10, 1928, The materials used were taken from the catches of small *baclad* (*siid*) made during the period from June to September, 1928, and from catches of *sakag*, from October to January, 1929. It was necessary to depend upon materials from catches of these two fishing gears, because they were the only ones in operation during the time which caught a satisfactory number of young kanduli for study. The procedure followed was to secure representative samples from individual catches at intervals of 30 days. The fish composing each sample were measured and grouped in length frequencies. Chart 3 shows frequency polygons formed by a series of measurements made from June 10, 1927, to January 6, 1929.

It will be seen from chart 3 that the collection of young fish made during the month of June measured from 3.0 to 5.1 cm. long with a modal length of 4.2 cm. The subsequent collection made in July showed a range of measurements from 3.0 to 5.4 but with a mode of 4.5 cm. which showed practically little increase in growth. In the August collection, the range was 3.0 to 6.0 cm. with a mode of 4.5 cm. showing thus no increase in modal length but a slight increase in the upper size limits of young fish. These figures indicate very slight increase in the growth of fish during a period of one month. In the September collection the range was 3.6 to 7.2 cm. with

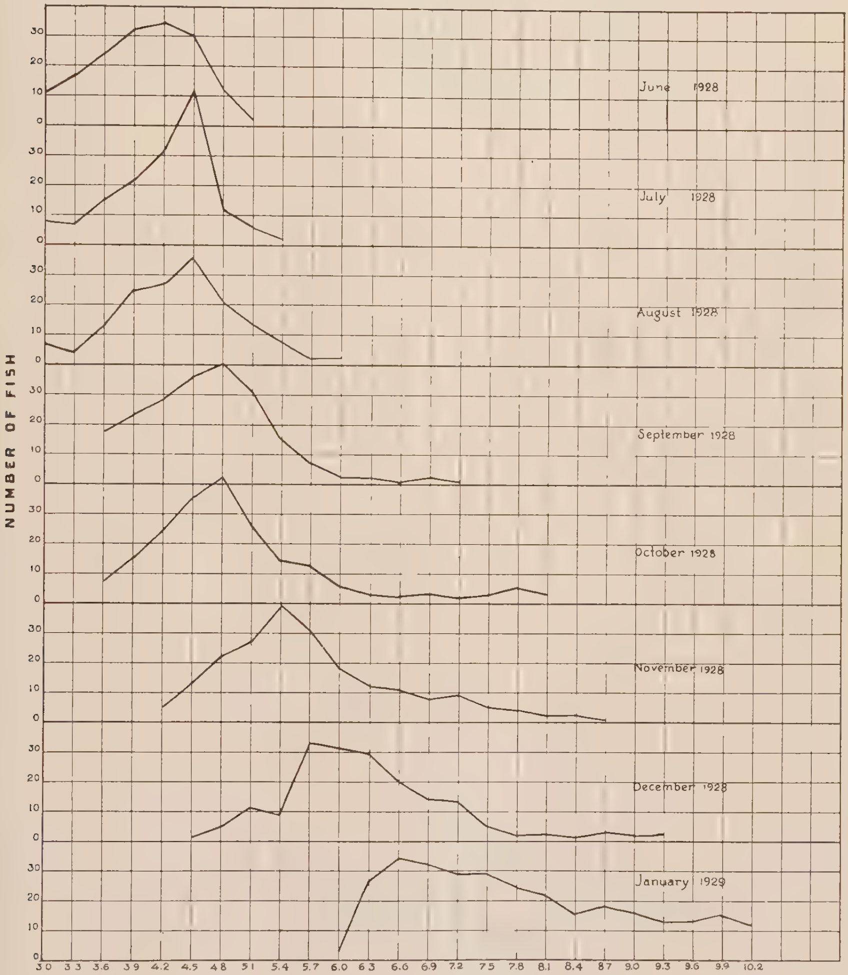

Chart 3.—Frequency polygons of lengths of young kanduli from baclad and sakag June, 1928, to January, 1929.

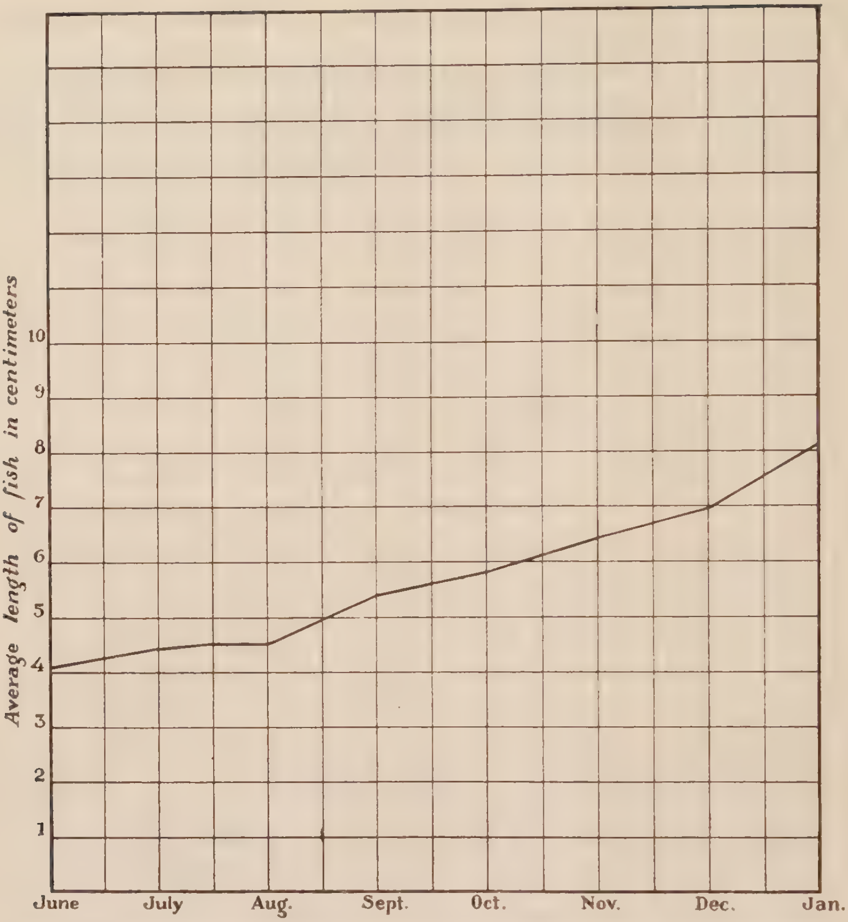

Chart 4.—Average monthly lengths of young kanduli, June, 1928, to January, 1929.

a mode of 4.8 cm., thus showing again another slight increase in the rate of growth of the young fish. In October, the range was 3.5 to 8.1 cm. with a mode of 4.8 cm. indicating a slight progress in the upper-size limits of the length of the young fish. In November, the range was 4.2 to 8.7 cm. with a mode of 5.4 cm. In December the range was 4.5 to 9.3 cm. with a mode of 5.7 cm. In January the range was 6.0 to 10.2 cm. with a mode of 6.6 centimeters.

Referring once more to chart 3 the movement of the upper and lower size limits of the fish, together with the modes formed, can be seen, indicating the rate of growth of the young fish from May to January. From this chart the average of the lower and upper size limits of the length of young kanduli taken from June, 1928, to January, 1929 are graphed separately in chart 4. By examining the course of the curve in chart 4, it may be seen that the fish has grown at a minimum rate of 3.0 cm., at a maximum rate of 6.5 cm., an average rate of 3.9 cm., and a modal rate of 2.4 cm. in the course of seven months, from June, 1928, to January 1929.

b. Growth of kanduli that were taken in pukot hauls. Dip nets (*salok*) were used to secure representative samples from the *pukot* hauls. Sampling was done by dipping the net at random into the entire catch of any single haul of the *pukot* and all the fish thus taken measured. Measurements were made at intervals of 30 days.

Chart 5 gives the frequency polygons showing the age groups of samples taken from September, 1927, to April, 1928, a period of eight months. The average and modal lengths of fish under different age groups are shown in table 9.

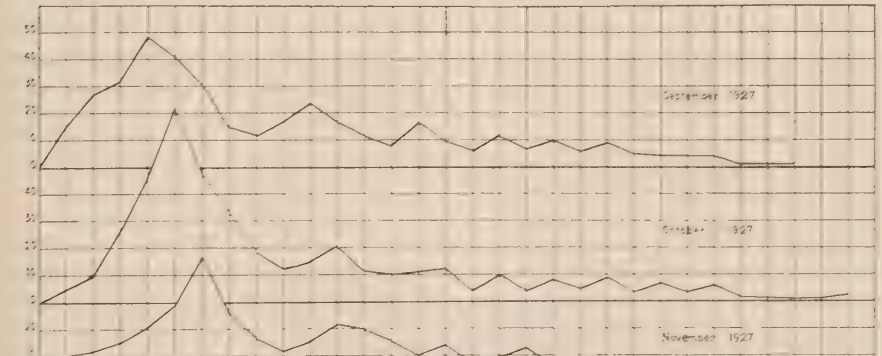

Chart 5.—Frequency polygons of lengths of kanduli from pukot September, 1927, to April, 1928.

The collection made during September, 1927, showed that fish measuring from 9.5 to 15.5 cm. long tended to center in an age group with a mode of 12.5 cm. In a previous discussion of the growth of the young kanduli it was shown that the fish reached an upper size limit of 10.2 cm. long with an average length of 8.1 cm. in seven months. It is, therefore, deemed reasonable to regard that fishes measuring from 9.5 to 15.5 cm. with an average length of 12.5 cm. and a mode of 12.5 cm. must belong to the first age group; the second age group of fish measuring from 16.5 to 21.5 cm. long, with an average length of 18.0 cm. and a mode of 18.5 cm; the third age group measuring from 21.5 to 24.5 cm., with an average length of 23.0 cm. and a mode of 22.5 cm.; the fourth age group, ranging from 24.5 to 26.5 cm., with the average length of 25.5 cm. and a mode of 25.5 cm.; the fifth age group ranging from 26.5 to 28.5 cm., and a mode and an average length of 27.5 cm.; the sixth age group, from 28.5 to 30.5 cm., a mode and average of 29.5 cm. The seventh, the eighth and older age groups did not distinctly appear in the frequency polygons, probably because the fish belonging to these age groups were either absent or not sufficiently represented in the catch, as large and old fish are easily depleted by overfishing and death from old age.

In the collections made in October, the first age group consisted of fish measuring from 9.5 to 18.5 cm. with an average of 13.5 cm. and a mode of 13.5 cm. Other age groups were similar to the corresponding ones in the previous month in the range of measurements as well as in their modes.

The collections made in November produced similar results, except that the modes of the first, second, and third age-groups increased to 14.5, 19.5, and 23.5 cm. long respectively, indicating that rapid growth took place in the first three age groups. The older age groups registered no change. In December none of the age groups changed either in their range of measurements or in their modes. In the collection of January the range in the first age group was from 9.5 to 18.5 with a mode of 15.5 cm., the second age group from 18.5 to 22.5 cm. with a mode of 20.5 cm., the third age group from 22.5 to 26.5 with a mode of 23.5 cm., the fourth age group from 26.3 to 28.3 cm., with a mode of 27.5 cm. There was no change in range and modes evident in the other age groups.

In the collection of February, 1928, a new frequency polygon appeared in the graph before the first age group that was formed in September. This newly formed frequency polygon was taken to represent a group of very young fish derived from the eggs spawned in the early spawning run of 1927. The finding on the rate of growth of very young kanduli closely checked up with these results. The collections made in March and April did not show any appreciable change in range either in the lower and upper size limits or in their modes, except in the case of the newly formed group which in February ranged from 9.5 to 12.5 cm. long with a mode of 10.5 cm. In April the measurements ranged from 9.5 to 12.5 cm. with a mode of 11.5 cm.

In the foregoing discussion, the following are the salient features:

(1) Six distinct size groups of fish, representing the first, second, third, fourth, fifth, and sixth age groups, were defined in the length-frequency measurements made from September, 1927, to April, 1928. Size groups representing the seventh and eighth age groups were not distinctly defined in the frequency polygons.

(2) The average lengths of fish belonging to the different age groups have been calculated as follows:

AGE GROUPS	AVERAGE LENGTH *cm.*
I	13.88
II	20.18
III	24.00
IV	26.83
V	28.93
VI	31.10
VII	32.50
VIII	33.50

The average increments in the different age groups were computed as follows: of the fish belonging to the first age group, average increments were determined by subtracting the average length of the newly formed larvae from the average length of the first age group measurements. The yearly rate increments of the second and subsequent age groups were determined by subtracting the average measurements of the younger from the next older. The following calculated increments for each age group have been calculated by that method:

AGE GROUPS	LENGTH *cm.*
I	10.88
II	6.30
III	3.82
IV	2.81
V	2.17
VI	2.07
VII	1.40
VIII	1.00

The foregoing figures show that the rate of growth, on the average, is fastest in the first age group, relatively slower in the second age group and then decreases progressively with the increasing age of the fish, until it remains almost stationary in the eighth age group.

(3) In March, and April, there was no appreciable increase either in the lower or the upper size limits or in modes of the different age groups, except in one newly formed fish in February, indicating that the very young fish were the ones which grew, while the mature fish remained constant. This lack of increase is explained by the fact that the breeding activities of the fish took place during the middle part of February to April (chart 2).

Sexual maturity of female kanduli

In determining the age at which the fish become sexually mature, a series of dissections of material consisting of 100 fish in each lot was made at intervals of one week from February 17, 1928, to May 27, 1928. The smallest sexually mature fish were isolated by using ovarian contents of eggs in groups II and III as criteria. Only females were used in this determination.

After examining a large number of fish, the writer recognized certain external criteria which distinguished a male from a female. The female fish was found to possess invariably a cartilaginous structure (plate 1, fig. 2) on each of the ventral fins, which was highly developed during the breeding season. The ventral fins of the female become thick and very vascular at this time. After the spawning season, about the month of September, this cartilaginous structure disappears, except in some of the largest fish where this structure was observed to be retained for some time after the end of the breeding season.

It will be seen from table 8 that the fish measuring from 13.5 to 16.5 cm. long with an average length of 14.4 cm. are generally sexually mature. Fish of these measurements were found to possess the cartilaginous structure which appears only in breeding female fish. From the previous discussion relating to the rate of growth of fish that were caught in *pukot* hauls, it was stated, among other things, that fish measuring an average length of 14.4 to 16.5 cm. belong to the second age group.

Food and feeding habits of mature kanduli

The fish used for this determination were taken from catches of *baclad* (fish corrals); *pante* (gill nets); and *pukot* (seines) in different portions of the lake and at different times of the year. The stomachs of the large fish were carefuly removed and preserved in ten per cent formalin. The fingerlings were preserved whole. Collections of stomach samples were made from January to December, 1928.

To obtain the monthly range of the food of the fish, twenty stomachs of mature fish and twenty of the fingerlings were collected, dissected, and examined each month.

Chart 6 shows the results of the examination of the stomachs of the mature fish.

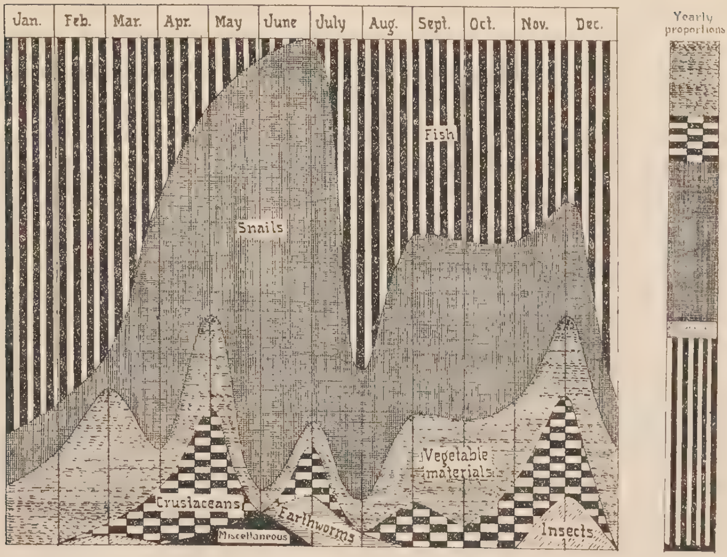

Chart 6.—Principal items in the food of mature kanduli showing the relative proportions of each by bulk from month to month.

a. Fish food. From chart 6 it will be seen that about 41.05 per cent of the total annual food consumption of the kanduli was composed of other species of fish. The greatest consumption of fish as food of kanduli occurred during two periods, from January to March and from September to December. Among the species of fish taken from the stomachs of the kanduli were *ayuñgin* (*Pristopoma hasta*) and *biya* (*Glossogobius* spp.). The former were taken in larger amounts than the latter.

It may be of interest to state here that a few males actually carrying eggs and larvae in their mouths were found to contain these materials in their stomachs. In many cases, however, the males were found to have empty stomachs. One explanation suggests itself for the presence of the eggs and larvae in the stomachs of breeding males; namely, accidental swallowing of the contents of the buccal cavity when the male is forced to eat because of extreme hunger. This contention is based on the fact that a few males having eggs in their mouths were found to contain shrimps and other food consitutents in their stomachs. It is doubtful if the kanduli is normally cannibalistic.

b. Molluscan food. The snails ranked second in importance among the food of the kanduli. These constituted about one-third of the total annual consumption of the fish. The greatest consumption of snails occurred during the month of June when it formed 76.05 per cent of the total food for that month. In several instances, the alimentary tracts of the fish contained nothing but snails which numbered more than two hundred in each stomach. From July to November, consumption of snails was almost constant, averaging about 31.28 per cent of the total bulk for each month. During December, January, and February, the fish ate the smallest number of snails.

The species of snails that were eaten by the fish are here enumerated, approximately in the order of their abundance. They are: *Melania scabra* Muller, *Melania pantherina* von den Busch, *Vivipara angularis* Muller, and *Melania asperata* Lamarck[5].

c. Crustaceans. The crustaceans as food of kanduli formed about 7.09 per cent of the total animal food consumption. Among these are fresh-water shrimps (Palaemonidae) and fresh-water crabs (Potamonidae). Of these two, the first is eaten in the greater quantity. It was in only two instances, during December and January, that the fish were found to contain fresh-water crabs.

The crustaceans were eaten in great quantities in April and May, or during the breeding season.

d. Vegetable food. Vegetable matter was found in the stomachs to the amount of about 13.82 per cent of the total bulk of annual food consumption. Data obtained from the examination of the stomach contents of the fish showed that it is more carnivorous than herbivorous. Vegetable matter was found to be eaten by the fish throughout the year; from January to February and from August to December, it was eaten in a slightly larger amount than during the rest of the year.

e. Earthworms and insects. Earthworms and insects constituted the least of the animal food eaten during the year. The earthworms were eaten only during June and July, probably because during these months earthworms are abundant on the shores and thence were probably washed into the lake. They form about 1.02 per cent of the total annual food of the fish.

The insect food constituted about one per cent of the total amount of annual food of the fish; this food consisted mainly of water beetles, spiders, and naiads of Odonata. They were found in the alimentary tract of the fish during November and December, when there were frequent hard SE, ESE, and E winds striking the lake and dislodging large numbers of water hyacinths near the shores. These aquatic plants harbor much insect life.

f. Other food constituents. Among the other food constituents of the fish may be mentioned mud, sand, and fish hooks. These were, however, very rare. These materials were probably swallowed by the fish accidentally with other food.

The following is a summary of the food habits of the mature kanduli:

(1) This fish is largely carnivorous, eating other kinds of food in very sparse quantities.

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[5] Determinations by Howard R. Hill, conchologist of the Los Angeles Museum, Los Angeles, California.

(2) Fish, snails, and crustaceans form the major portion of the animal food of the kanduli.

(3) Coelhelminthes (earthworms) and insects were taken in small quantities.

(4) The vegetable part of the food of the fish ranks fourth in amount of the total annual consumption of food, the amount having been calculated to be 13.3 per cent of the entire bulk.

g. Food of young kanduli. Samples of stomachs of young kanduli (mostly fingerlings) were collected from the field each month during the year 1928, and preserved in ten per cent formalin solution. Examination of the stomach contents showed that they were both plant and animal feeders. About 40.25 per cent of their annual diet was composed mostly of algae and a duckweed, locally known as *lia* (*Lemna paucicostata* Hegelm.), and the rest consisted of crustaceans, snails, insects, earthworms, fish, named in the order of their abundance.

The monthly range of these food constituents is given in table 8 and represented graphically in chart 7.

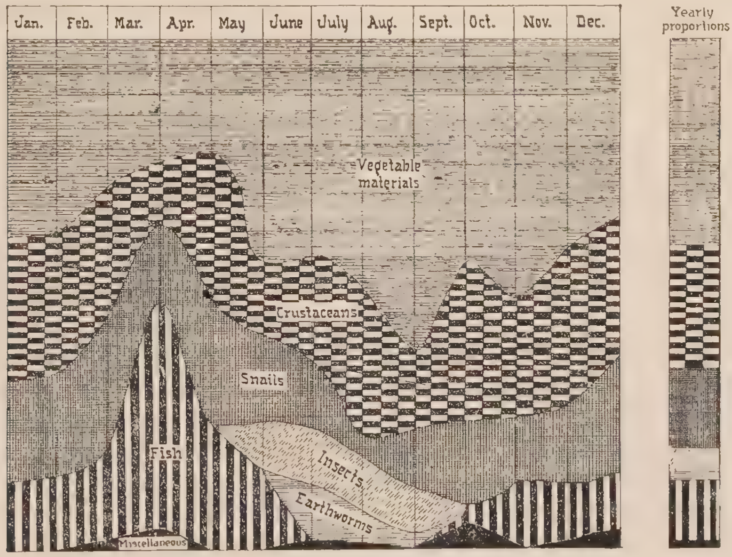

Chart 7.—Principal items in the food of young kanduli showing the relative proportions of each by bulk from month to month.

The most conspicuous difference between the mature and young kanduli in their feeding habits is the amount of vegetable food materials eaten. It is apparent from the results of stomach content examination that the newly hatched fish are first vegetable feeders, becoming carnivorous as they become older. Very old fish were found to be almost entirely carnivorous.

The greatest consumption of vegetable food (mostly *lia* and algae) was found to take place from May to November. This is probably because during other months, in summer, *lia* and algae seem to be poisonous to fish. It must be remembered that during these hot months, the disagreeable odor coming from Laguna de Bay is traceable to the rapid, almost wholesale decomposition of these plants.

Another matter of interest in connection with the feeding habits is that crustaceans (shrimps and copepods) form an important food for the young fish, while in the adult fish, this group is very insignificant.

The insects were eaten in greater quantities by the young fish than by the adult fish. This is because the young kanduli inhabits for the most parts the shallower portions of the lake where aquatic insects are usually found. Among the insects found were beetles, naiads of dragon flies; and ants. Spiders were also found.

The fish food of the fingerlings constituted 1.65 per cent of the total food for the year. These food materials are probably not the preferred kind as they are large and not easily swallowed. The fish taken were *ayuñgin* (*Pristopoma hasta*) and *dulong* (*Miragobius lacustris*).

The earthworm was least represented in the stomachs of the fingerlings.

Other stomach constituents of the fish are mud and sand which amounted to 11.85 per cent of the total food for the year.

Migratory movements of the kanduli

Field observation were made on the migratory movements of the kanduli in Laguna de Bay. Opinion of experienced fishermen on the subject was also sought. Results of observations made on the composition of each of different fishing gears operated in different portions of the lake under varying conditions of the bottoms of the fishing banks, and operated at different periods of the year, were analyzed and interpretation as to the probable movements of the fish made therefrom. Likewise, the results of the findings on the examinations of stomach contents of the fish, both young and mature, collected at different times of the year were taken advantage of in interpreting the possible movements of the fish.

On the basis of these criteria, the following deductions as to the migrations of the kanduli are made.

First. At the approach of the breeding season, the mature males and females which are due to spawn during that season gather in schools. At first they swim about in the pelagic strata of the water, then just before spawning most probably migrate together to the bottom, usually in the deep portions of the lake. This assumption is based upon the following observations:

In the months of February and March large schools of kanduli are reported by fishermen. The *kanaway* prove a useful guide to the *pukot* fishermen, for they usually catch kanduli in large quantities when they operate their nets in areas indicated by these birds. Examination of catches during this time of the year showed that they were composed mostly of maturing females and males. Another criterion used by the fishermen to detect the presence of schools of fish during this time of the year is by the use of noise. Every little while the fishermen beat the side of the fishing boat to make a noise to frighten the fish. If a school of fish is in nearby waters, great numbers of bubbles are seen near the surface of the water. These bubbles are produced by the fish which have been scared by the sudden noise.

Another evidence advanced to show that fish first lead a pelagic life before migrating deeper to the bottom of the lake is the following observation: During January, February, and March the major portion of the food of the mature kanduli was found to be largely composed of pelagic fishes. During April, May, and June, a period which corresponds to the period of great activity, the food in the stomachs was mostly demersal forms, such as snails.

Second. There is a tendency for the females to leave the breeding grounds soon after spawning so as to get access to richer feeding grounds. This assumption is based upon the examination of the composition of a catch of *panie,* a fishing gear operated during the breeding season in water with a sandy and rocky bottom. It was found that the major portion of the catch consisted of mature spent females. The fish upon dissection showed that their ovaries contained ova which were no larger than those classified under intermediate class. Also, the genital opening and the condition of the ovaries showed characteristics of recent spawning. This assumption is further strengthened by the fact that *pukot* hauls made in the middle of the lake with a muddy bottom, were characterized by the marked absence of spent females.

Third. After the breeding season, during May to October, the young kanduli migrate to the shallower portions of the lake, usually near the shores. This statement is supported by the observations that the *baclad* which are operated near the shores, catch mostly fingerlings with only a few mature males. It was seldom that the females were found in these catches. This finding also shows that the female after spawning, does not seem to help the male in the care of the young. Another evidence which tends to show that fingerlings migrate towards the shore after the breeding season, is that the *sakag* and *seket* which are operated in shallow waters catch the fingerlings in large quantities. Again this supposition that the fingerlings migrate to the shallower shores from May to October is further supported by the findings of great quantities of *lia* and small crustaceans, such as shrimp in the stomachs of the fish. Both of these stomach contents are found in fish caught in shallow waters only.

Fourth. During the period from October to December, the fingerlings (both male and female) migrate to the rocky and sandy bottoms, especially near the small islands where the water is quiet. The *dala* and *pante*, both operated in these places, catch fingerlings in large quantities, while in other parts of the lake they catch only very few fish. The movement of this fish toward quiet waters is probably due to hard SE, ESE, and E winds striking the lake during this time of the year.

Fifth. It is further assumed that the young kanduli (fingerlings) have a free vertical migration, that is, freely moving from the bottom to the surface of the water and vice versa, during feeding. This is strongly indicated by the fact that both demersal and pelagic organisms were found in the stomachs of the fish almost uniformly throughout the year. The former are represented by floating aquatic plants and the latter by snails.

SUMMARY AND CONCLUSIONS

(1) Previous investigators have reported the existence of six species of Ariidae in Laguna de Bay, the most abundant being *Arius manillensis.* The dominance of this species is corroborated by the present investigation; in fact only the fish referable to that species were used in the present work.

(2) Very little is known concerning the life history and habits of the kanduli in the Philippines. The present study is an attempt to ascertain the rate of growth of the ova from the prespawning period to the postbrooding period; to determine the rate of growth of the fish, from the time the larvae are expelled from the mouths of the males, until they become sexually mature and a few years older; to determine the feeding habits; and to make observations on the migratory movements of the fish.

(3) The ova found within the ovaries of the kanduli may be roughly classed under three groups, namely: group I, or the *immature class,* of eggs; group II, or the *intermediate class;* group III, or the *maturing class.*

(4) *Group I ova* appear in the ovaries of the fish soon after maturity is attained and thereafter as long as the fish is living. These eggs are creamy white and measure from 0.08 mm. to 2.0 mm. in diameter.

(5) *Group II ova* make their appearance about five months after the spawning period of the fish. They measure from 2.0 to 3.5 mm. in diameter. The color is creamy white stippled with distinct black chromatophores.

(6) *Group III ova* begin to appear about seven and a half months after the spawning period of the fish. They measure from 3.50 to 10.75 mm. in diameter. From the time these eggs attain the 3.50 mm. diameter size, they become orange until maturity.

(7) The spawning season of the kanduli was found to last from the middle of February to the first week of May. Females are externally distinguished from the males during the breeding season by the cartilaginous enlargement of the first ental fin ray of each ventral fin.

(8) During the breeding season, four spawning runs apparently take place, the first occurring about the middle of February; the second, middle of March; the third, the middle of April; and the fourth, about the first

week of May. It seems that the intermediate class of eggs (group II ova) which were due to be spawned during that breeding season do not all develop into mature ova (group III ova) at the same time, but that they become ripe a few at a time, most probably one-fourth of the total number in a spawning run in a given breeding season.

(9) Soon after the eggs are spawned, the fertilized eggs are incubated in the mouths of the males and kept there until the larvae are able to swim actively and are able to seek their own food. At this time, all the stored yolky material is used and absorbed. The period covering the time when the eggs are picked up by the males to the liberation of the young larvae from the mouth is taken as the brooding period. It was found that the brooding period, on the whole, covers an interval of about two months.

(10) The young kanduli, as a rule, was found to increase at a minimum group rate of 3.0 cm., or at a maximum group rate of 6.5 cm., or an average group rate of 3.9 cm. in the course of seven months, from June to January.

(11) Six distinct size-groups representing the first, second, third, fourth, fifth, and sixth age groups were defined in the length frequency measurements of fish taken from *pukot* hauls, from September, 1927, to April, 1928.

(12) The average length of fish belonging to the different age groups were calculated to be as follows:

Age groups	*Average length in cm.*
I	13.89
II	20.18
III	24.00
IV	26.93
V	28.92
VI	31.10
VII	32.50
VIII	33.50

(13) The average rate of increment of fish belonging to the different age groups was calculated to be as follows:

Age groups	*Length in cm.*
I	10.88
II	5.30
III	3.81
IV	2.81
V	2.17
VI	2.07
VII	1.40
VIII	1.00

(14) During the breeding season, the fish was found to cease growing. This is explained by lack of nutrition during the season, as the fish eat hardly any food.

(15) The fish reach sexual maturity when from 14.4 to 16.5 cm. long.

(16) The mature kanduli is largely carnivorous. Fish, snails, and crustaceans formed the largest portion of the animal food; earthworms, and insects the least. The vegetable portion ranks fourth in the total annual food consumption of the mature fish, the amount having been calculated to be 13.3 per cent by bulk.

(17) The young kanduli were found to be very much more vegetarian in food habits than the adult fish. Forty per cent of its annual food consumption was of vegetable origin, mostly *lia* and algae. Crustaceans and snails formed the biggest portion of the animal food, the amounts being 24 and 17 per cent of the annual consumption, respectively. Insects, earthworms, and fish were found in the stomachs in small amount.

(18) At the approach of the breeding season, the mature males and females which are apparently due to spawn during the season gather in schools. There is a tendency for the females to leave the breeding grounds soon after spawning to gain access to richer feeding grounds. After the breeding season, during May to October, the young kanduli likewise migrate to the shallower portions of the lake, most probably also to find richer feeding grounds. From October to December the fingerlings, both males and females, apparently migrate to the rocky and sandy bottoms, especially near the small islands where the water is quiet, probably to take shelter from rough waters caused by the prevailing strong winds and at the same time to look for food which is characteristically found in shallow waters.

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TABLE 1

Diameter frequencies of ova during pre-spawning period; ova taken from 10 fish at intervals of 7 days

EGG DIAMETER	DIAMETER FREQUENCY																						
	1927																1928						
	11-IX	18-IX	24-IX	1-X	8-X	15-X	22-X	30-X	6-XI	13-XI	20-XI	27-XI	4-XII	11-XII	18-XII	25-XII	1-I	8-I	15-I	22-I	29-I	5-II	12-II
mm.																							
0.07— 0.1	21	12	15	7	5	5	9	8	11	15	8	12	7	8	9	7	7	8	14	11	8	5	13
0.11— 0.3	71	80	61	52	52	67	48	52	56	56	48	50	50	57	49	44	44	52	59	71	58	58	50
0.31— 0.5	39	38	39	32	37	24	27	37	26	28	33	30	34	31	34	29	33	33	32	29	27	31	29
0.51— 0.7	27	35	36	25	28	22	27	27	24	23	25	37	28	23	30	28	28	23	20	15	24	21	26
0.71— 0.9	27	26	35	25	19	22	34	28	30	24	25	21	24	24	28	29	27	21	15	18	22	23	26
0.91— 1.1	24	23	27	20	23	27	30	25	26	22	26	20	20	16	22	25	18	23	22	15	21	24	16
1.11— 1.3	20	23	20	30	31	25	26	17	28	27	29	15	25	24	23	22	20	23	14	14	11	13	8
1.31— 1.5	20	24	19	29	29	29	23	23	29	27	23	19	15	27	25	20	24	25	10	10	8	10	8
1.51— 1.7	22	19	17	30	29	32	20	18	27	25	30	26	24	20	20	18	22	20	10	12	7	11	5
1.71— 1.9	16	11	18	34	26	23	21	23	16	27	19	24	10	19	15	20	17	19	15	10	7	7	7
1.91— 2.1	13	9	13	16	21	23	17	24	16	15	17	15	15	16	12	17	15	15	10	9	11	10	5
2.11— 2.3	0	0	0	0	0	1	18	18	8	8	8	16	20	12	13	15	10	6	12	11	16	10	4
2.31— 2.5	0	0	0	0	0	0	0	0	4	5	11	8	10	8	10	12	11	6	17	11	7	10	7
2.51— 3.0	0	0	0	0	0	0	0	0	0	0	8	13	17	15	8	10	12	12	13	12	12	8	11
3.01— 3.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	6	9	4	13	10	9	8
3.51— 4.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	6	10	8	5	10	10
4.01— 4.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	10	12	3	4
4.51— 5.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5	7	2	6
5.01— 5.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	7	11	4	5
5.51— 6.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	5	6
6.01— 6.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	3	4
6.51— 7.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	4
7.01— 7.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	6
7.51— 8.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	3
8.01— 8.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5
8.51— 9.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
9.01— 9.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
9.51—10.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
10.01—10.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
10.51—11.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Total . . .	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300

TABLE 2

Diameter frequencies of ova during spawning period; ova taken from 10 fish at intervals of 7 days

EGG DIAM.	DIAMETER FREQUENCY															
	1928															
	17–II	24–II	3–III	10–III	17–III	24–III	21–III	7–IV	15–IV	22–IV	30–IV	7–V	15–V	22–V	29–V	6–VI
mm.																
0.07— 0.1	5	11	9	18	12	5	15	10	7	10	5	9	10	11	6	9
0.11— 0.3	43	56	42	58	39	46	67	53	53	53	46	47	48	45	55	50
0.31— 0.5	34	31	24	26	23	33	25	30	30	32	28	29	35	31	32	32
0.51— 0.7	23	26	19	17	20	27	20	25	26	25	28	25	29	27	24	27
0.71— 0.9	27	20	20	13	16	28	15	20	23	25	30	27	27	26	22	30
0.91— 1.1	17	23	18	14	17	20	18	19	20	22	21	24	23	25	27	34
1.11— 1.3	19	22	21	10	10	18	13	9	24	25	26	23	25	29	29	29
1.31— 1.5	20	19	20	19	14	22	11	8	25	13	19	20	23	25	25	23
1.51— 1.7	20	21	18	10	11	22	12	5	20	15	14	18	17	23	32	20
1.71— 1.9	16	20	19	17	11	20	9	6	23	23	13	19	18	18	27	25
1.91— 2.1	17	16	13	17	13	19	10	4	15	16	16	17	12	16	21	21
2.11— 2.3	15	13	14	5	17	10	12	5	18	17	15	16	13	10	0	0
2.31— 2.5	12	10	13	3	12	15	10	9	7	5	7	12	9	9	0	0
2.51— 3.0	7	4	16	4	16	11	12	9	6	7	3	10	7	5	0	0
3.01— 3.5	3	2	9	6	11	8	13	0	10	3	2	2	4	0	0	0
3.51— 4.0	1	3	5	6	2	10	10	0	10	2	1	2	0	0	0	0
4.01— 4.5	0	2	6	9	17	6	6	0	7	1	2	0	0	0	0	0
4.51— 5.0	0	2	4	4	3	0	7	0	0	5	1	0	0	0	0	0
5.01— 5.5	0	0	3	8	8	0	6	9	0	2	3	0	0	0	0	0
5.51— 6.0	0	0	4	4	9	0	7	5	0	3	4	0	0	0	0	0
6.01— 6.5	0	0	2	4	6	0	2	3	0	5	2	0	0	0	0	0
6.51— 7.0	0	0	1	7	4	0	0	5	0	2	1	0	0	0	0	0
7.01— 7.5	1	0	0	2	5	0	0	8	0	0	1	0	0	0	0	0
7.51— 8.0	2	0	0	4	5	0	0	11	0	0	2	0	0	0	0	0
8.01— 8.5	4	0	0	6	4	0	0	8	0	0	1	0	0	0	0	0
8.51— 9.0	5	0	0	3	6	0	0	4	0	0	1	0	0	0	0	0
9.01—10.0	6	0	0	0	4	0	0	10	0	0	2	0	0	0	0	0
9.51—10.0	5	0	0	0	4	0	0	5	0	0	1	0	0	0	0	0
10.01—10.5	2	0	0	0	3	0	0	2	0	0	1	0	0	0	0	0
10.51—11.0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Total.........	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300

TABLE 3

Ratio of maturing to intermediate ova at different times during the breeding season

DATE	NO. OF FISH EXAMINED	AVE. NO. OF MATURING OVA	AVE. NO. INTERMEDIATE OVA	RATIO OF MATURING TO INTERMEDIATE OVA
1928				
17–II	10	6	75	1:12.5
3–III	10	8	81	1:10.3
17–III	10	10	95	1: 9.5
31–III	10	7	51	1: 7.3
15–IV	10	9	49	1: 5.4
30–IV	10	10	36	1: 3.6
10–V	10	5	13	1: 2.6

TABLE 4

Sex of kanduli with eggs or larvae in mouth

DATE	NO. FISH EXAMINED	NO .MALE	NO. FEMALE
10–V–1927	20	19	1
6–VI–1927	30	30	—
15–VII–1927	35	35	—
5–VIII–1927	36	36	—
17–II–1928	43	43	—
10–III–1928	26	26	—
7–IV–1928	35	35	—
10–V–1928	24	24	—

TABLE 5

Length frequencies of young fish from measurements at intervals of 30 days (baklad and sakag)

LENGTH OF FISH	LENGTH FREQUENCIES							
	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.
cm.								
3.1— 3.3	11	8	7	0	0	0	0	0
3.4— 3.6	17	7	4	0	0	0	0	0
3.7— 3.9	24	15	13	17	7	0	0	0
4.0— 4.2	32	22	25	23	15	0	0	0
4.3— 4.5	34	31	27	28	24	5	0	0
4.6— 4.8	30	52	36	36	35	13	2	0
4.9— 5.1	12	12	21	40	42	22	5	0
5.2— 5.4	2	6	13	31	25	27	11	0
5.5— 5.7	0	0	8	15	14	39	9	0
5.8— 6.0	0	0	2	7	12	30	33	0
6.1— 6.3	0	0	2	2	5	18	31	2
6.4— 6.6	0	0	0	2	3	12	29	26
6.7— 6.9	0	0	0	1	2	11	20	34
7.0— 7.2	0	0	0	2	3	8	14	32
7.3— 7.5	0	0	0	1	2	9	13	29
7.6— 7.8	0	0	0	0	3	5	5	29
7.9— 8.1	0	0	0	0	5	4	2	24
8.2— 8.4	0	0	0	0	3	2	2	22
8.5— 8.7	0	0	0	0	0	2	1	15
8.8— 9.0	0	0	0	0	0	1	3	18
9.1— 9.3	0	0	0	0	0	0	2	16
9.4— 9.6	0	0	0	0	0	0	2	13
9.7— 9.9	0	0	0	0	0	0	0	13
10.0—10.2	0	0	0	0	0	0	0	15
10.3—10.5	0	0	0	0	0	0	0	12
Total.......	162	153	158	205	200	208	184	310

TABLE 6

Length frequencies of fish from measurements at intervals of 30 days (pukot)

LENGTH OF FISH	LENGTH FREQUENCY							
	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MARCH	APRIL
cm.								
9.1—10	15	5	10	5	3	5	10	9
10.1—11	27	10	12	16	15	13	25	20
11.1—12	32	27	16	24	17	11	18	27
12.1—13	49	46	21	29	18	16	15	20
13.1—14	41	72	29	35	22	20	23	18
14.1—15	31	48	48	39	76	23	29	30
15.1—16	15	33	26	22	30	25	32	34
16.1—17	12	18	17	15	15	15	20	25
17.1—18	17	12	12	8	10	9	18	15
18.1—19	24	15	15	13	5	8	12	13
19.1—20	17	21	23	20	7	7	10	10
20.1—21	12	12	20	8	13	11	11	19
21.1—22	8	10	16	3	5	14	16	25
22.1—23	17	12	10	10	4	7	12	15
23.1—24	10	13	14	13	10	5	10	13
24.1—25	6	4	7	5	4	10	15	20
25.1—26	12	10	9	3	3	4	10	15
26.1—27	7	4	13	7	7	3	8	13
27.1—28	10	8	6	3	5	5	13	17
28.1—29	6	5	8	3	2	2	8	5
29.1—30	9	9	9	5	5	3	7	7
30.1—31	5	4	5	3	3	4	10	10
31.1—32	4	7	8	7	4	4	8	5
32.1—33	4	4	5	4	2	3	8	0
33.1—34	4	6	2	2	2	2	7	0
34.1—35	1	3	0	0	0	0	2	0
35.1—36	1	1	0	0	0	0	4	0
36.1—37	1	4	0	0	0	0	1	0
37.1—38	0	1	0	0	0	0	0	0
38.1—39	0	1	0	0	0	0	0	0
39.1—40	0	1	0	0	0	0	0	0
Total.......	397	416	361	312	239	209	360	341

TABLE 7

Average monthly percentage of male kanduli with eggs in the mouth when caught in backlad

DATE	NO. FISH EXAMINED	NO. FISH WITH EGGS IN MOUTH	PERCENT OF FISH WITH EGGS IN MOUTH	AVERAGE PERCENTAGE FOR MONTH
1928				
12–II	392	38	9.59	15.84
19–II	484	58	12.17	
24–II	339	52	15.66	
4–III	436	77	17.64	24.92
11–III	372	93	25.00	
18–III	395	112	28.39	
25–III	426	122	28.65	
1–IV	352	121	34.37	32.63
7–IV	362	187	33.45	
15–IV	378	117	30.95	
22–IV	426	123	39.11	
29–IV	382	98	25.68	
6–V	266	42	15.79	14.37
12–V	232	34	14.59	
19–V	293	51	12.76	

TABLE 8

Minimum length of kanduli with intermediate and maturing eggs

DATE	NO. FISH EXAMINED	MIN. LENGTH OF KANDULI WITH INTERMEDIATE OR MATURING EGGS
1928		*cm.*
12–II	100	16.5
17–II	100	15.5
24–II	100	16.0
4–III	100	14.0
11–III	100	14.3
18–III	100	14.5
25–III	100	14.0
1–IV	100	13.7
7–IV	100	14.0
15–IV	100	13.8
22–IV	100	13.5
29–IV	100	13.5
6–V	100	14.0
12–V	100	14.5
17–V	100	13.5
Average.......	100	14.4

TABLE 9

Average and modal lengths of kanduli under different age groups

AGE GROUPS	SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER		JANUARY		FEBRUARY		MARCH		APRIL		AVERAGE	
	MODE	AVE. OF RANGE	MODE	AVE. OF RANGE	MODE	AVE. OF RANGE	MODE	AVE. OF RANGE	MODE	AVE. OF RANGE	MODE	AVE. OF RANGE	MODE	AVE. OF RANGE	MODE	AVE. OF RANGE	MODE	AVE. OF RANGE
I	12.5	13.0	13.5	13.5	14.5	13.5	14.5	13.5	15.5	14.0	15.5	14.5	15.5	14.5	15.5	14.5	14.1	13.88
II	18.5	18.0	19.5	19.0	19.5	20.0	19.5	19.5	20.5	21.5	21.5	21.5	21.5	21.0	21.5	21.0	20.25	20.18
III	22.5	23.0	22.5	23.0	23.5	23.5	23.5	23.5	23.5	24.0	24.5	25.0	24.5	25.0	24.5	25.0	24.62	24.00
IV	25.5	25.5	25.5	25.5	26.5	26.0	26.5	27.0	26.5	27.0	27.5	27.5	27.5	28.0	27.5	28.0	29.0	26.81
V	27.5	27.5	27.5	27.5	29.5	27.5	29.5	29.5	29.5	33.0	—	—	30.5	30.5	30.5	30.5	31.50	28.93
VI	29.5	29.5	29.5	29.5	31.5	32.5	31.5	33.0	31.5	—	—	—	—	—	—	—	31.50	31.10
VII	—	—	31.5	32.5	—	—	—	—	—	—	—	—	—	—	—	—	33.50	32.50
VIII	—	—	33.5	33.5	—	—	—	—	—	—	—	—	—	—	—	—	—	33.50

TABLE 10

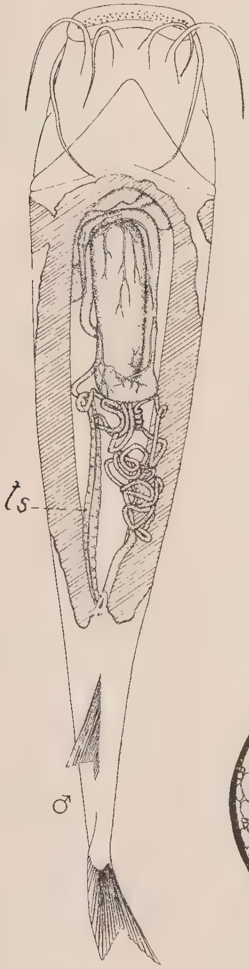
Monthly range of food constituents of young kanduli

FOOD	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	AVE.
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cen'*	*per cent*
Vegetable matter.....	38.55	29.43	24.76	22.03	43.27	42.18	48.27	62.19	43.57	51.68	41.32	35.72	40.25
Crustaceans...	28.25	26.28	13.24	28.93	14.32	20.29	30.20	14.28	30.32	23.73	31.26	27.32	24.03
Snails........	18.20	27.42	15.73	26.72	17.25	15.25	4.63	12.46	18.25	13.25	15.67	23.63	17.46
Insects.......	—	—	—	—	10.54	10.00	10.25	8.93	—	—	—	—	3.31
Earthworm...	—	—	—	—	—	10.02	5.30	2.14	—	—	—	—	1.45
Fish.........	15.00	14.25	41.65	21.32	13.62	—	—	—	2.61	11.34	9.85	10.10	11.65
Other constituents......	—	2.62	4.62	—	—	2.26	1.35	—	6.25	—	1.90	3.23	1.85
Total........	100	100	100	100	100	100	100	100	100	100	100	100	100

TABLE 11

Monthly range of food constituents of mature kanduli

FOOD	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	AVERAGE
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Fish and fish fragments...	76.20	65.05	33.50	16.35	6.50	—	67.65	38.90	40.50	40.25	32.90	74.80	41.05
Snails........	9.05	4.95	49.75	40.45	84.55	76.05	24.25	36.50	36.75	32.90	26.70	8.00	35.82
Crustaceans...	—	2.00	9.50	28.75	—	9.65	—	9.00	3.75	12.50	10.30	0.20	77.09
Insects.......	—	1.10	—	—	—	—	—	—	—	—	10.60	—	0.97
Earthworms..	—	—	—	—	—	10.00	2.25	—	—	—	—	—	1.02
Vegetable matter.....	14.75	26.90	7.25	12.45	2.93	4.30	5.85	15.60	19.00	14.35	19.50	17.00	13.34
Other constituents......	—	—	—	2.00	6.00	—	—	—	—	—	—	—	0.68
Total........	100	100	100	100	100	100	100	100	100	100	100	100	100



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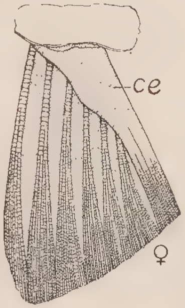

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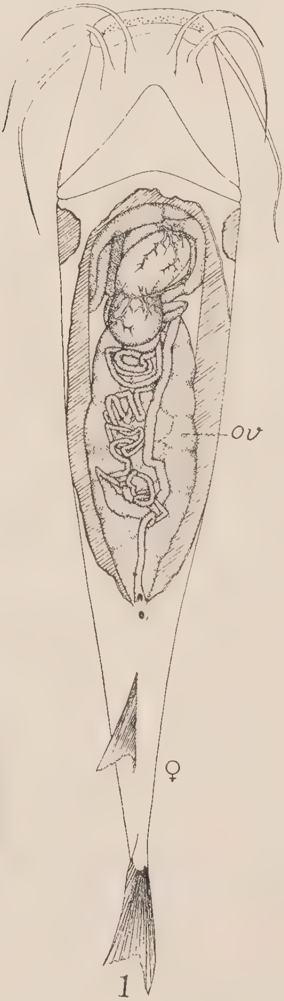

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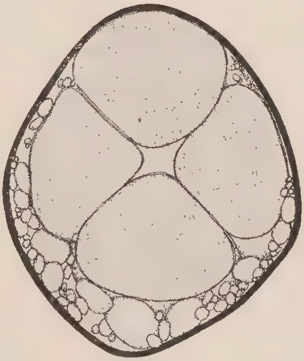

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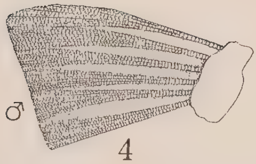

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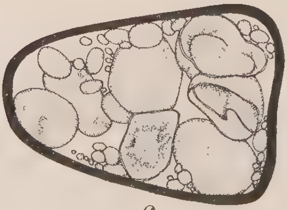

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PLATE 1

Fig. 1. Female kanduli showing internal organs; ovary with mature ova. *ov*, ovary ×2/3.
Fig. 2. Ventral fin, female, during spawning season. ×2/3 *ce*, cartilaginous enlargement.
Fig. 3. Male kanduli showing internal organs including mature testes. *ts*. testis. ×2/3
Fig. 4. Ventral fin, male, during spawning season. ×2/3
Fig. 5. Cross section of mature ovary, showing ova of groups I, II, and III. ×3
Fig. 6. Cross section of mature ovary of kanduli at end of spawning season, showing some ova in process of degeneration. ×4

THE PROXIMATE CHEMICAL ANALYSIS OF PHILIPPINE FOODS AND FEEDING STUFFS: II[1]

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WITH THE TECHNICAL ASSISTANCE OF

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Department of Agricultural Chemistry

This publication contains the results of chemical analyses of samples submitted to this laboratory from 1925 to the early part of 1928. The results of chemical tests of numerous samples which were submitted for analysis for only one or two constituents are not included. The samples were received from various sources but the major part came from different departments of this College, particularly from the Departments of Chemistry, Animal Husbandry, and Agronomy.

The old system of sample notation was to give a number to each item of material. The samples have so increased that the numbers were becoming too large to be convenient, so during the latter part of last year another system was adopted. This system is apparent from the tables. Besides simplicity in numbers, this method has the advantage of showing in the table of results the year the sample was analyzed. The first two figures represent the year and those following, the serial number of the samples.

The analytical methods employed are the same as those given by the latest revision of the *Official and Tentative Methods of Analyses.* For nitrogen and ether-extract determinations, the author has introduced slight modifications which have given very satisfactory results. These modifications will be described in later papers.

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[1] Experiment Station contribution No. 611. Received for publication September 25, 1928.

TABLE 1

Analyses of some common Philippine salted and smoked fishes

EXPER. STA. NO.	SAMPLE	REFUSE	EDIBLE PORTION	MOISTURE	ASH	FATS	PROTEINS	CARBOHYDRATES	CRUDE FIBER	FUEL VALUE PER 100 GRAMS
		per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*calories*
852	Bañgos, *Chanos chanos* Forskal	——	——	15.19	12.68	11.78	59.22	0.57	0.56	355
743	Candule, *Arius* spp.	——	——	8.59	5.43	8.13	76.31	1.30	0.24	394
27–31	Dilis, *Anchovia* sp.	——	——	18.72	13.83	1.71	64.75	0.82	0.17	285
27–59	Tinapa, *Clupeidae*, smoked fish	41.18	58.82	52.95	8.19	1.59	36.33	0.79	0.16	167
27–58	Tuyo, *Clupeidae*, dried salted fish	48.87	51.13	42.30	14.46	5.84	35.50	1.68	0.22	207

TABLE 2

Analyses of roots and tubers

EXPER. STA. NO.	SAMPLE	EDIBLE PORTION	MOISTURE	ASH	FATS	PROTEINS	CARBOHYDRATES	CRUDE FIBER	FUEL VALUE PER 100 GM.
		per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*calories*
528	Apulid, *Eleocharis dulcis* (Burm. f.) Trin.	——	61.34	1.23	0.15	0.32	35.48	1.48	148
953	Canna, edible, *Canna* sp.	——	76.77	1.50	0.52	1.28	12.76	7.17	62
985	Cassava (angular), *Manihot utilissima* Pohl.	——	74.18	1.10	0.18	1.10	22.29	1.15	98
984	Cassava (Kapo White), *Manihot utilissima* Pohl.	73.78	47.49	1.33	1.62	2.68	45.82	1.06	214
27–64	Ginger, *Zingiber officinale* Rosc.	——	84.55	5.09	0.58	1.97	6.33	1.48	39
547	Poñgapong stem, *Amorphophallus campanulatus* (Roxb.) Blume, air dry	——	5.47	5.91	——	6.69	77.12	4.81	344
549	Sincamas, *Pachyrrhizus erosus* (Linn.) Urb., air dry	——	9.86	3.72	5.42	5.54	71.01	4.45	364

TABLE 3

Analyses of Philippine fruits

EXPER. STA. NO.	SAMPLE	REFUSE	EDIBLE PORTION	MOISTURE	ASH	FATS	PROTEINS	CARBOHYDRATES	CRUDE FIBER	FUEL VALUE PER 100 GRAMS
		per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*calories*
27–106	Camias (fresh fruit) *Averrhoa bilimbi* Linn.	——	——	94.86	0.36	1.39	0.68	2.10	0.61	24
27–78	Green mango (fresh) *Mangifera indica* Linn.	24.51	75.49	87.33	0.38	0.08	0.69	10.59	0.93	47
546	Mabolo (air dry) *Diospyros discolor* Willd.	——	——	13.81	3.26	5.82	3.39	66.18	7.54	339
27–77	Santol (fresh) *Sandoricum koetjape* (Burm. f.) Merr.	38.68	61.31	86.44	0.78	1.43	0.91	8.14	2.30	50
548	Santol (air dry) *Sandoricum koetjape* (Burm. f.) Merr.	——	——	4.28	5.15	15.25	3.47	61.94	9.91	410
27–84	Tamarind (green fruit) *Tamarindus indica* Linn.	——	——	78.05	1.06	0.93	2.31	11.88	5.77	67

TABLE 4

Analyses of horse's milk

SAMPLE	NO. OF ANALYSES	SPECIFIC GRAVITY	MOISTURE	ASH	BUTTER FAT	PROTEINS $N \times 6.38$	LACTOSE	CASEIN	ALBUMIN BY DIFFERENCE
			per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Mare's milk I	14	1.0342	90.07	0.36	1.12	2.06	6.55	1.09	0.97
Mare's milk II	7	1.0349	90.58	0.38	0.65	1.90	6.91	1.26	0.64
Mare's milk III	9	1.0342	89.85	0.38	1.62	2.14	6.35	0.86	1.28
Average for mare's milk	30	1.0344	90.17	0.37	1.13	2.03	6.60	1.07	0.96

TABLE 5

Analyses of cheese made at the College of Agriculture

SAMPLE	NO. OF ANALYSES	MOISTURE	ASH	BUTTER FAT	CASEIN	REDUCING SUGARS	SODIUM CHLORIDE	ACIDITY EXPRESSED IN CC. OF 0.1 N NaOH PER 100 GRAMS
		per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	
Cebu style								
Cheese made from buffalo's milk	4	45.22	4.74	27.74	21.39	0.93	2.00	14.39
Cheese made from native carabao's milk	4	43.73	4.69	27.25	23.08	0.99	1.84	11.16
Cheese made from native cow's milk	4	47.67	4.65	23.77	23.93	0.89	1.95	12.08
Cheese made from Indian cow's (Nellore) milk	4	47.00	4.77	17.25	27.57	0.91	1.81	12.27
Santa Cruz style								
Cheese made from buffalo's milk	7	58.65	4.22	20.17	14.50	2.47	1.98	13.46
Cheese made from carabao's milk	7	54.29	4.15	23.94	14.83	2.61	1.90	10.34
Cheese made from native cow's milk	7	56.03	3.96	17.36	16.48	2.30	1.80	8.41
Cheese made from Indian cow's (Nellore) milk	9	52.73	4.32	19.59	19.96	2.03	1.90	11.06

TABLE 6

Analyses of miscellaneous Filipino foods

EXPER. STA. NO.	SAMPLE	MOISTURE	ASH	FATS	PROTEINS	CARBOHYDRATES	CRUDE FIBER	FUEL VALUE PER 100 GRAMS
		per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*calories*
27–74	Bagoong (alamang), salted small shrimps	67.27	20.49	1.15	10.38	None	0.79	53
27–15	Balayba (cintas-cintasan) *Vallisneria gigantea* Graebn	15.95	21.03	3.72	14.81	33.02	11.47	231
27–62	Bicho-bicho (Chinese fritter)	27.62	1.18	7.71	8.75	54.52	0.22	331
27–75	Bukayo (sweetened shredded coconut meat)	8.43	0.70	6.40	0.85	78.41	5.21	384
741	Coconut haustorium	15.23	9.39	15.68	10.69	38.42	10.59	347
780	Coconut meat (shredded)	44.96	1.06	32.92	1.22	2.27	17.57	320
854	Eggs, preserved (Chinese)	68.79	3.83	8.65	13.27	5.46	——	157
27–24	Himbabaong lalake, *Allaeanthus luzonicus* (Bloc.) F. Vill	15.31	8.49	5.10	26.69	33.99	10.42	295
27–25	Malungay, *Moringa oleifera* Lam	17.98	7.66	1.74	18.13	42.12	12.37	263
27–73	Mamon, from Los Baños Bakery, plain cake	21.62	1.06	12.93	8.66	55.40	0.33	383
27–13	Papait (Ilocano), *Mullugo oppositifolia* Linn	10.79	17.45	2.40	17.85	36.54	14.97	245
27–85	Puto seco, from Pampanga (baked rice cake)	7.23	0.42	1.24	5.72	84.97	0.42	383
27–60	Putong pute (steam-cooked rice cake)	49.92	0.54	1.34	2.98	45.49	0.23	211
27–14	*Ragra gotirit* (algae)	7.98	27.41	1.66	16.54	35.44	10.97	229
27–65	Satsaron (roasted pig skin)	12.96	1.03	22.01	41.22	22.20	0.58	465
611	Toyo ("Superior", from Sengkee & Co.), soy sauce	64.27	21.12	0.59	6.56	7.46	None	63
27–16	Yuro (made from buri palm)	11.90	8.99	1.23	0.47	77.19	0.22	330

TABLE 7

Analyses of concentrate feeds

EXPER. STA. NO.	SAMPLE	NO. OF ANALYSES	MOISTURE	ASH	ETHER EXTRACT	PROTEINS N×6.25	CARBOHYDRATES	CRUDE FIBER	FUEL VALUE PER 100 GRAMS
		per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*calories*
532	Copra meal (Pampanga Sugar Mills)	1	7.70	7.26	9.48	18.79	47.43	9.34	360
702	Copra meal (Filma Mercantile)	1	9.66	6.14	7.80	17.91	47.40	11.09	340
	Copra meal (Animal Husbandry Department)	3	15.63	6.30	7.68	18.79	42.13	9.47	321
844	Fish meal	1	9.56	18.11	2.53	57.99	11.58	0.23	309
27–51	Japanese feed—(Code word, Zosmu)	1	12.48	7.26	6.78	42.41	26.38	4.69	345
27–52	Japanese feed—(Code word, Zorbi)	1	12.37	5.37	4.16	45.94	26.40	5.76	335
819	Oats—Horse's feed (U. S. Army)	1	11.53	3.43	1.44	9.16	61.99	12.45	305
	Rice bran (Animal Husbandry Department)	12	12.48	12.60	4.58	15.85	37.16	17.33	260

TABLE 8

Analyses of grasses

SAMPLE	NO. OF ANALYSES	MOISTURE	ASH	ETHER EXTRACT (FATS)	PROTEINS N × 6.25	CARBOHY-DRATES	CRUDE FIBER	FUEL VALUE
		per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*calories*
Aguingay (air dry), *Rottboellia exaltata* Linn. f.	1	9.38	15.19	0.76	5.41	38.77	30.49	188
Aguingay (fresh)	5	69.29	4.02	1.27	2.23	13.33	9.86	76
Ambabanguet (5 weeks old), *Synedrella nodiflora* (Linn.) Gaertn.	1	79.74	8.33	1.14	1.97	5.32	3.50	40
Barit (air dry), *Leersia hexandra* SW.	1	24.10	14.04	1.76	7.04	29.94	23.12	168
Barit (fresh	1	70.91	4.63	1.55	1.81	12.40	8.70	73
Batad-batadan (air dry), *Andropogon halepensis* (Linn.) Boot.	1	12.43	9.23	0.40	4.63	43.61	29.70	202
Bermuda grass (fresh), *Cynodon dactylon* (Linn.) Pers.	1	42.73	6.14	0.79	8.10	26.95	15.29	151
Bermuda grass (air dry)	1	10.08	7.53	2.20	6.41	51.50	22.28	258
Carirawaw grass (fresh), *Digitaria corymbosa* (Roxb.) Merr.	1	71.57	4.42	0.76	2.01	12.86	8.38	68
Carirawaw (air dry)	1	9.96	11.66	1.83	5.78	45.32	25.45	227
Cogon (air dry), *Imperata cylindrica* Linn. Beauv.	2	7.87	9.30	1.51	5.19	38.14	37.99	182
Cogon (fresh)	5	68.02	2.99	1.00	2.37	14.41	11.21	78
Culape (fresh) *Paspalum conjugatum* (Berg.)	5	74.47	2.95	1.04	1.84	12.23	7.47	67
Corn leaves (air dry), *Zea mays* (Linn.)	1	12.61	9.03	1.43	9.29	43.11	24.53	227
Corn forage (fresh)	3	57.77	1.54	1.13	1.00	33.12	5.44	150
Dawa-dawa, *Panicum crus-galli* (Linn.)	1	15.31	9.68	0.42	3.66	44.05	26.88	199
Guatemala (4 weeks old), *Tripeacum laxum*.	1	85.15	3.18	1.98	2.13	1.52	6.04	23
Guinea grass (fresh), *Panicum maximum* Jacq.	22	68.47	4.63	1.29	2.39	13.64	9.58	67
Guinea grass (10 days old), *Panicum maximum* Jacq.	1	78.23	3.66	0.45	3.94	8.43	5.29	55
Guinea grass (20 days old)	1	74.22	4.19	0.51	2.97	11.38	6.73	64
Guinea grass (30 days old)	1	68.81	4.67	0.57	3.10	11.48	11.37	65
Guinea grass (40 days old)	1	73.17	3.50	0.41	2.19	12.87	7.86	57
Guinea grass (50 days old)	1	69.33	5.61	0.68	2.28	9.49	12.61	55
Guinea grass (60 days old)	1	73.84	3.34	1.98	1.38	9.84	9.62	64
Guinea grass (70 days old)	1	80.64	2.31	1.31	1.16	7.94	6.64	49
Guinea grass (80 days old)	1	76.41	3.45	0.69	1.10	10.43	7.92	55
Guinea grass (90 days old)	1	68.75	4.12	1.88	1.28	11.52	12.45	71
Guinea grass (100 days old)	1	73.67	3.36	0.84	1.03	10.58	10.52	55
Ipil-ipil leaves (air dry), *Leucaena glauca* (Linn.) Benth.	1	53.30	3.60	1.38	28.56	6.27	6.89	155
Ipil-ipil leaves (dry)	1	10.18	8.17	2.31	23.88	27.11	28.35	231
Macahia (air dry), *Mimosa pudica* Linn.	2	10.16	4.95	2.62	14.52	49.30	18.45	286
Macahia (5 weeks old), *Mimosa pudica* Linn.	1	73.79	1.02	2.28	4.63	11.65	6.63	89
Mixture of grasses from open pasture	1	76.34	3.36	2.28	1.56	10.25	6.21	70
Mani-manian (air dry), *Desmodium capitatun* Burm. f.	1	9.86	12.25	4.06	16.63	38.20	19.00	263
Merker grass (fresh), *Pennisetum merkeri officinarium*	4	83.04	3.36	0.59	1.71	6.42	4.88	39
Napier grass (fresh), *Pennisetum purpureum*	4	82.32	3.24	0.59	1.60	6.61	5.64	39
Napier grass (air dry)	2	11.15	13.88	0.85	7.28	41.06	25.78	206
Paraguis (air dry), *Eleusine indica* (Linn.) Gaertn.	1	11.09	12.75	1.97	6.88	45.10	22.21	231
Paspalum conjugatum (air dry)	1	10.89	9.97	0.61	4.88	50.77	22.88	234
Para grass (fresh), *Panicum barbinode*	2	74.38	2.60	2.04	1.39	14.10	5.49	82
Pennisetum sotosum (8 weeks old)	1	91.69	2.19	0.57	1.16	1.17	3.22	15
Pennisetum sotosum (4 weeks old)	1	90.71	2.52	0.27	1.56	2.26	2.68	18
Rice hay (cured), *Oryza sativa* Linn.	1	12.77	10.52	2.01	3.44	45.39	25.87	219
Rice plants (fresh)	2	71.52	4.73	4.15	1.64	9.40	8.56	84
Sabung-sabuñgan (air dry), *Panicum flavidum* Retz.	1	14.01	12.49	0.26	8.35	40.35	24.54	202
Sectaria palmifolia (air dry)	1	8.90	12.28	0.23	7.88	41.32	29.39	204
Sugar cane tops, *Saccharum officinarum* Linn.	1	73.76	2.45	0.81	2.06	8.91	12.01	53
Talahib grass (air dry), *Saccharum spontaneum* Linn.	2	13.30	11.13	1.05	6.38	35.03	33.11	180
Talahib grass (right age for feeding)	1	79.29	2.36	0.52	1.51	8.06	8.26	44
Tiribuhan (air dry), *Panicum colonum* Linn.	1	10.40	18.27	1.65	6.72	38.93	24.03	203

COLLEGE AND ALUMNI NOTES

Plans are under way to celebrate the twentieth anniversary of the College of Agriculture some time during the coming academic year. The date has been tentatively set around October 10, 1929. Definite announcement will be made later by the general committee on arrangements, of which Dr. N. B. Mendiola is chairman.

At the last University Commencement, March 26, 1929, forty-nine candidates received degrees in agriculture. The complete list follows:

I. BACHELOR OF AGRICULTURE

(a) General Curriculum

1. Acosta, Catalino P. [1]
2. Atienza, Juan D.
3. Bandong, Cesario C.
4. Bondoc, José
5. Briones, Alfonso Q. [1]
6. Carandang, Brigido G.
7. Cayabyab, Cipriano B.
8. Cayabyab, Domingo J.
9. Coronel, Arsenio Y. [2]
10. Cruz, José O.
11. Guia, José P.
12. Hernandez, Silvino
13. Lumang, Honorato E.
14. Mane, Andres M.
15. Matela, Arcadio C.
16. Mejia, Agustin J. [1]
17. Mendoza, Eduardo A.
18. Padlan, Felix A.
19. Pidlaoan, Nazario
20. Sonza, Isabelo
21. Ungos, Paulino M.
22. Ynalvez, Lauro

(b) Animal Husbandry Curriculum

1. Gaviola, Vicente D.
2. Santa Romana, Conrado

II. BACHELOR OF SCIENCE IN AGRICULTURE

(a) General Curriculum

1. Bayog, Melquiades
2. Celino, Martin S.
3. Cruz, Eligio C.
4. Cruz, Marcos de la
5. Elazegui, Ernesto E.
6. Fabello, Sebastian F.
7. Jacomina, Pedro
8. Maulit, Dimas [3]
9. Nisperos, Petronilo M.
10. Relova, Felizberto
11. Varona, Albino
12. Vidal, Albino.

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[1] Graduation approved by the Faculty of the College of Agriculture and recommended to the University Council October 23, 1928.

[2] Graduation approved by the Faculty of the College of Agriculture and recommended to the University Council November 22, 1928.

[3] Graduation approved by the Faculty of the College of Agriculture and recommended to the University Council October 23, 1928.

(b) *Animal Husbandry Curriculum*

1. Garrido, Juanito T.
2. Ong, Valeriano S.
3. Zaratan, Ananias M.

(c) *Combined Animal Husbandry and Veterinary Curriculum*

1. Gallardo, Cornelio R.

(d) *Supplementary Curriculum*

1. Gutierrez, Servillano C. [4]
2. Viado, Basilio O., B. Agr. '22.

(e) *Sugar Technology Curriculum (Certificate)*

1. Esmeralda, Emilio Z. [5]
2. Villa, Felipe M. [5]

III. CANDIDATE FOR THE CERTIFICATE IN SUGAR TECHNOLOGY

1. Rosales, Hermenegildo R. [6]

IV. BACHELOR OF SCIENCE IN SUGAR TECHNOLOGY

1. Bermejo, Genaro C. (Cum laude)
2. Eubanas, Elias C.
3. Hemedes, Enrique D.
4. Isaac, Federico G.

Mr. Genaro C. Bermejo, '29, was awarded the Joaquin J. Gonzalez Medal for the highest scholastic record maintained during his term of residence as a student in the College of Agriculture. The closest competitors for this honor weie Honorato E. Lumang and Nazario Pidlaoan.

Dean Gonzalez was the commencement speaker at the graduation exercises held in the Pampanga Agricultural School at Magalan on April 6, 1929.

The San Nicolas Elementary School of Manila held its annual commencement in the Auditorium of the College of Agriculture on March 23, 1929. Prof. Merle A. Foster, head of the Department of Agricultural Education of this College was the commencement speaker.

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[4] Mr. Gutierrez has completed within the same academic year, 1928–1929, B. Agr. General and B.S.A. Supplementary Curricula. Only the latter degree was conferred.

[5] Graduation approved by the Faculty of the College of Agriculture and recommended to the University Council October 23, 1928.

[6] Approved by the Faculty of the College of Agriculture, and recommended to the University Council for the Certificate in Sugar Technology, October 23, 1928.

The third Battalion of the Department of Military Science and Tactics of the University held its graduation program in the College Auditorium on March 15, 1929. Major Dean Hudnutt, of the General Staff Corps, who was the guest of honor, awarded the certificates and medals to the following cadets:

1. Cadet Maj. Agustin Hermano (Agr.)
2. Cadet Maj. Fernando Fernandez (Agr.)
3. Cadet Capt. Manuel Villano (Agr.)
4. Cadet Capt. Porfirio Jain (Agr.)
5. Cadet Capt. Conrado Sta. Romana (Agr.)
6. Cadet Capt. Leonardo Banaag (Agr.)
7. Cadet Capt. Marcelino Garcia (Agr.)

ANNUAL MEDALS

Leadership Medal......	Cadet Capt. Conrado Sta. Romana
Marksmanship Medal...	Cadet 1st Lieut. Salvador Oliveros
Loyalty Medal.........	Cadet 1st Lieut. Arturo Baluyot
Honor Medal..........	Cadet Major Fernando Fernandez
Duty Medal...........	Cadet 1st Sgt. Gerardo Capati

MEMBERS OF THE U. P. RIFLE TEAM

Cadet Major Fernando Fernandez
Cadet 1st Lieut. Salvador Oliveros
Cadet 2nd Lieut. Felix Enrile
Cadet 2nd Lieut. José Gaton
Cadet Guillermo Palis

On the evening of March 11 last, a Japanese sukiyaki dinner was given by Mr. Tei Ishii at the Nippon Kan Hotel at Los Baños to which the deans and heads of the various departments of the Colleges of Agriculture and Veterinary Science and the School of Forestry, their wives, and the staff of the Department of Entomology were invited. Judging from the enthusiasm of those present to partake of the deliciously prepared Japanese dishes by using chop sticks in the Japanese style, the party was a success. Mr. Ishii is assistant entomologist of the Imperial Experiment Station, Tokyo, Japan, who has been temporarily detailed by his Government to work at the College of Agriculture.

The Dean and Mrs. Gonzalez honored the Senior Class of 1929 by a *merienda* at Molawin Hall on Thursday afternoon, March 14.

Mrs. Vicente Lava landed in the United States about the middle of March along with Mr. and Mrs. Pflueger of the Forestry School who are now in Los Angeles. Mrs. Lava will spend most of her vacation on Long Island.

The forty-first meeting of the Los Baños Biological Club was held in the College Auditorium on January 31, 1929, at which the following papers were read:

The Nagoya, a new immigrant from Japan.
By Dr. F. M. Fronda and Dr. B. M. Gonzalez.

The effect of tapping coconut palm for toddy on the production of copra and oil.
By Mr. F. A. Soliven.

First-year rotation of tobacco, corn and mongo.
By Mr. José C. Ramos.

The Los Baños Biological Club held its forty-second scientific program in the Auditorium on February 28.

The following papers were read:

The diet of beri-beri families in Nueva Ecija and Cavite.
By Dr. F. O. Santos.

A cheap and apparantly effective method of field control of sugar cane white grubs, *Leucopholis irrorata* Chevr.
By Dr. L. B. Uichanco.

A carcinoma in a Cantonese hen.
By Drs. A. K. Gomez and A. Gonzaga.

The forty-third scientific meeting of the Los Baños Biological Club was held in the College Auditorium on March 7. The following papers were read:

Color blindness among College of Agriculture students.
By Professor R. H. King and Mr. G. Guanzon.

Composition of natural pastures with special reference to climate.
By Mr. Calixto Y. Zamuco.

Asexual inheritance of twin character of banana branches.
By Messrs. T. Mercado and J. M. Capinpin.

The members of the Faculty expressed their regret at the departure of Lt. Amado Martelino and his wife by tendering them a *despedida* dinner in Molawin Hall on March 15, 1929.

Miss Anne Cole and Miss Caroline Lee of the English Department spent their summer vacation in Northern China.

Southern Medicine and Surgery has the following comment on Preparation of Scientific and Technical Papers (Trelease and Yule): "A plain, understandable exposition of a difficult subject, which gives reasons. It would be a fine thing if a copy were in the hands of every doctor who writes. It helps us to understand what we read."

An illustrated article by Doctor Fronda on poultry in the Philippines appeared in the January, 1929 issue of *The Poultry Item*, a popular magazine published in Sellersville, Pennsylvania. As the editor of this magazine has put it, the article contains "interesting facts and peculiar sidelights on the chicken business in Uncle Sam's far-away land and some evidence of 'growing pains'."

Prof. Emma S. Yule left in April on a year's leave of absence. She is spending sometime on a tour of the Oriental countries, and then later she expects to go to the United States, via Europe.

At the Fourth Pacific Science Congress in Batavia, Java, Professors R. L. Pendleton and L. B. Uichanco, of this College, were among the official delegates of the Philippine Government. Prof. Yule and Mrs. Pendleton attended as participants.

The College of Agriculture began the present academic year on June 10, 1929, with a total enrollment of 749 students. Of this number 193 were new and all of them high school graduates. These figures do not include the students in the College Rural High School, which has a class roll of 190 students. A number of applicants had to be refused admittance on account of lack of accommodation in both the College and the High School.

In a recent election of the student body of the College the following officers were chosen to serve during the first semester: president, Artemio E. Gesmundo; vice-president, Felix N. Camba; secretary, Felixberto Turingan; treasurer, Salvador Oliveros; athletic representative, Briccio Reynoso; track manager, Pedro Yatar; director of orchestra, Mariano Perlas; and editor, Honorio Samonte.

In the forty-fourth scientific meeting of the Los Baños Biological Club on July 2, 1929, the following papers were read:

Determination of age of water buffaloes by the eruption of temporary and permanent incisors.—Dr. Valente Villegas.

The spawning habits of kanduli, Arius spp., in Laguna de Bay.—Mr. Andres M. Mane.

THE 1928–1929 MILLING SEASON OF THE COLLEGE SUGAR MILL

The small central, built by Dr. Manuel L. Roxas and operated by the Department of Chemistry, closed its sixth milling season on February 21, 1929. Operations started on January 18, but numerous delays due to interruption in cane supply, machinery, and weather hindered full operation. On January 21, the central was running 24 hours a day.

On account of the severe typhoon in November, 1928, the cane delivered to the mill was of very poor quality. It did not take many tons of this cane to completely fill the boiling house and to block continuous operation. Juice purities were low, but the central milled all cane in its endeavor to produce as much sugar as possible.

Difficulty was also encountered on account of the prolonged rainy season. It was impossible to dry the bagasse and what fuel was on hand was thoroughly soaked. Recourse was made to bagasse purchased from the Pampanga Sugar Development Co. This bagasse enabled the mill to continue operations until the weather cleared up.

The season was cut short: 91 tons of College cane were milled and 43 sacks of sugar produced. A very large amount of molasses was made, but this will result in a very high sucrose molasses being used by the Animal Husbandary Department for the feeding of animals.

All departments of the College co-operated in the operation of the mill. Nine students were given first-hand information on the operation of a centrifugal central. Considering the difficulties experienced, these students fully realize the problems to be encountered in commercial sugar production. Every one of these nine students received training in the operation of the major stations of a central. Particular attention was paid to clarification and boiling systems. Every effort was made to produce a commercial sugar, which could be sold in local markets for direct consumption.

Extensive improvements are being made during this off-season in the boiling house. With these and a general rearrangement of equipment and the installation of additional settling tanks and resettlers, the filler press station will be eliminated, and a greater recovery of sugar will be possible.

—R. H. King.

A CARCINOMA IN A CANTONESE HEN[1]

A. K. GOMEZ AND A. C. GONZAGA
Of the College of Veterinary Science

WITH ONE TEXT FIGURE

The great physiologic demand on the reproductive system of chickens, as a result of the intensive development of the poultry industry in comparatively recent years, is largely responsible for the frequent occurrence of tumors in the avian species. A large variety of neoplastic growths in chickens has been reported. Ehreinrich (quoted by Tyzzer and Ordway, 1909) examining 2,000 mature hens brought to a hotel, found seven malignant tumors of which five were distinct carcinomata. Curtis (1915) reported that out of 880 birds autopsied at the Maine Agricultural Experiment Station, 79, or 8.98 per cent, had tumors of one kind or another. He also found that 7.39 per cent of birds under two and one-fourth years of age and 19.17 per cent of those over that age revealed neoblastomas on autopsy. In the females which show by far the greater proportion of neoplasms, Curtis observed that the genital organs are the most frequent location for their formation—37.76 per cent in the ovaries and 18.36 per cent in the oviduct and its ligaments.

Pick (quoted by Tyzzer and Ordway, 1909) described a squamous-cell carcinoma of the floor of the mouth in a hen, and a similar tumor was described by Koch (quoted by Tyzzer and Ordway, 1909). The latter author reported "cystoma pennifera" in hens and geese which he considered analogous to dermoids in mammals.

Whartin (quoted by Tyzzer and Ordway, 1909), after studying a number of cases of leukemia in chickens, concluded that aleukemic and leukemic forms of lymphocytoma which appear analogous to similar conditions in man exist in the avian species.

Pickens (1914) reported a case of cysto-adenoma in a Plymouth Rock hen in 1913 consisting of numerous nodules ranging in size from 1 cm. to 6 cm. in diameter. Several of these nodules, particularly the larger ones, contained cysts filled with thin, straw-colored fluid. These cysts were of varying sizes up to 5 millimeters in diameter.

The case herein described is that of a carcinoma in a Cantonese hen and is the first malignant tumor in a chicken that has come to our attention in the Philippines.

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[1] Experiment Station contribution No. 610. Read before the Los Baños Biological Club February 28, 1929. Received for publication February 29, 1929.

THE PHILIPPINE AGRICULTURIST, VOL. XVIII, NO. 3, AUGUST, 1929.

HISTORY

The carcass of the Cantonese hen weighed 1.8 kilograms. It belonged to the Poultry Division of the College of Agriculture. It was brought to the College of Veterinary Science for autopsy in the morning of November 5, 1928, with the information that it was found dead the previous night, without having shown any signs of disease.

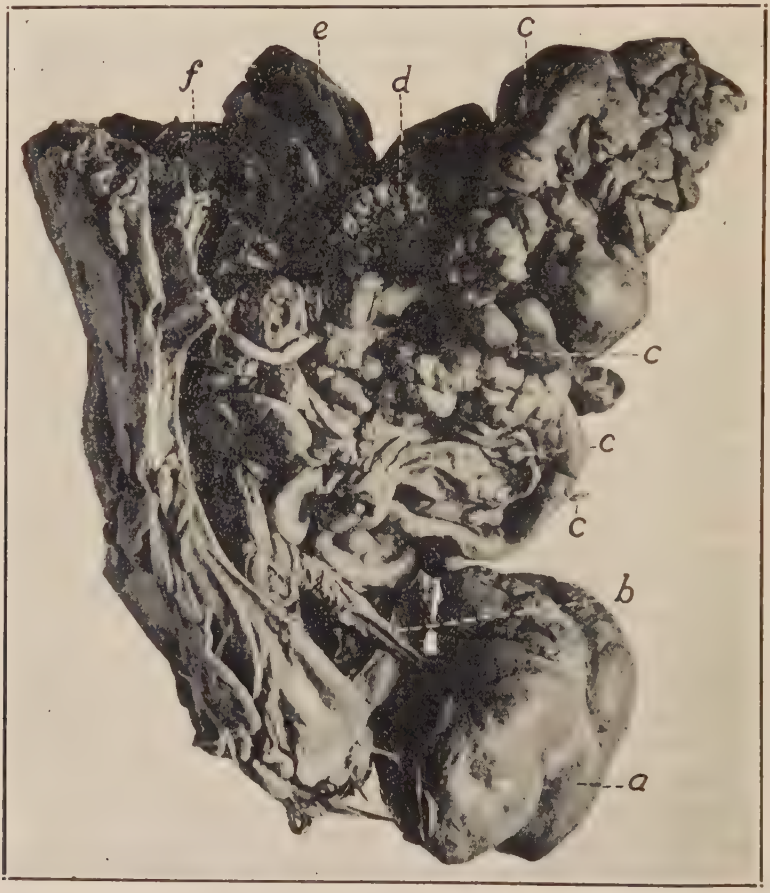

Fig. 1—Abdominal organs of a hen showing carcinoma nodules of various sizes.

a, large nodule; *b*, pedicle; *c*, small nodules, sessile or pedunculated; *d*, conglomerated nodules between large lobes of liver; *e*, liver; *f*, spleen.

MORBID ANATOMY

External examination. Bird in fair condition; rigor mortis absent; algor mortis present in abdomen; feathers ruffled; eyes and beak closed and dry; comb and wattles cyanotic; anal opening moist and adjacent feathers matted together by a greenish yellow fecal discharge; crop partly filled with food.

Internal examination. The subcutis is dry. The blood is dark red and does not coagulate readily. On opening the abdominal cavity, about 200 grams of a serous, sanguinous fluid is present in the peritoneal cavity. The peritoneum is congested and presents several hemorrhages. Numerous tumor growths, ranging in size from that of a grain of sago to that of a hen's egg, are present throughout the external surface of the walls of the small and large intestines, the proventriculus, the visceral aspect of the gizzard, and throughout the mesentery. Some appear as minute elevations; others are sessile and many are more or less pedunculated. Pressing them between the thumb and the index finger, they feel firm in consistency. The largest of them (pl. 1, *a*) weighs about 112.5 grams and has a dimension of 9×5.5×5 centimeters. It is invested in a thin, fibrous connective tissue capsule which is continuous with the pedicle. This pedicle measures 5 centimeters in length and is attached to the visceral surface of the oviduct (pl. 1, *b*) at the ischial region. It is imperfectly divided into two or three lobes and has a glistening greyish white appearance. On sectioning, it appears mottled with reddish brown and greyish white. The reddish brown areas are due to slight hemorrhage. The other nodules, some sessile and others distinctly rounded, are white and are closely apposed to the walls of the intestines (pl. 1, *c*). They do not extend into the lumen of the digestive tract. Metastases in other organs, such as the lungs, spleen, kidneys, ovaries and peritoneum, are not visible to the unaided eye. A flattened mass of conglomerated minute nodules is found lodged between the two large lobes of the liver (pl. 1, *d*). On close inspection this mass of nodules is seen to be closely attached to the visceral surface of the liver and on section it is seen that the growth invades the substance of the liver.

Pieces of the liver, spleen, intestines, kidney, lung, and the largest tumor growth, as well as some of the small nodules, were fixed in Zenker's fluid and also in formaldehyde solution, they were then dehydrated, cleared in xylene and imbedded in paraffin. They were sectioned and stained with haematoxylin and eosin and with Mallory's connective tissue stain. The histologic sections of the liver show local collections of epithelial cells in alveolar arrangement. They form duct-like structures from which dense masses of deeply stained cells radiate and apparently infiltrate the surrounding tissue. The ducts are narrow and on transverse section are seen to be lined with simple cuboidal cells. The hepatic cells surrounding the tumor are in various stages of degeneration but those farthest away are well stained and appear unaltered.

Sections taken from different tumor nodules show the same histologic appearance. The salient feature is the predominance of the cellular elements over the intercellular substance. The cells are deeply stained, quite large and generally round; some are elongated and others are irregularly shaped because of compression by adjacent cells. The cell contour is not distinctly defined. There is a variation in the size of the cells, as well as in the size of the nuclei. The nucleus is bladder-like or vesicular with rather coarse chromatin granules. Some cells have two or more nuclei. Some of these nuclei are eccentrically located in the cells. Numerous mitotic figures are scattered here and there. The cytoplasm appears as a narrow homogenous band around the vesicular nucleus. In cells with nuclei eccentrically placed the cytoplasm assumes a crescentic form. Between the tumor cells is a small amount of reticulated connective tissue stroma with spindle-shaped nuclei. The connective tissue fibrils are delicate and hardly recognizable, particularly in places where the cells are densely massed. They occur in coarser strands near the blood vessels and where the cells are few. The tumor is quite vascular. Many of the blood vessels are engorged with red blood cells which are extravascularly located in some places, indicating that hemorrhage had taken place. Focal areas of necrosis are present in which no cells are distinguishable and wherein only granules of chromatin and cell detritus can be seen. Bordering these foci of necrosis are cells in different degrees of degeneration showing pyknotic nuclei. In a few places distinct cellular infiltrations are seen. The section obtained from the large pedunculated tumor growth (pl. 1, *a*) shows glandular arrangement consisting of narrow ducts, some cut transversely and others obliquely. The epithelium in those ducts cut squarely across is composed of a single layer of cuboidal cells while in those cut obliquely the appearance of containing several layers of epithelium is seen. This glandular arrangement is observable only in sections of the liver and the large nodule. There are no cysts nor evidence of cystic degeneration in any of the histologic sections examined.

Transverse sections of the intestines show that the tumor does not extend beyond the serous coat but owing to pressure some of the intestinal glands have undergone degenerative changes. Sections of the spleen, kidneys, and lungs show engorgement of the blood vessels with red blood cells and several localized cellular infiltrations. There are no evidences of tumor formation in these organs.

DISCUSSION

In discussing the characteristics of epithelioblastoma, Mallory (1914) states:

> "For a papilloma which infiltrates, the term papillary carcinoma is often employed For an adenoma which invades the clinical term malignant adenoma is in common use. infiltrating would be better; still better in all these instances is the simple term carcinoma; The type of growth matters little; all these types may be combined in one tumor. The one essential point is the invasion of the surrounding tissue.
>
> "Another way of making these statements is as follows: a carcinoma is always malignant; a papilloma or an adenoma may be; if it is, it is best then to call it a carcinoma."

In the case herein described, the type cell of the tumor is distinctly that of the epithelioblast. Its glandular structure in some places, like the liver and the large pedunculated tumor growth, shows characteristically an adenomatous proliferation. Mitotic figures are numerous, showing rapidity of growth, and, together with extensive involvement of the digestive tract, constitute evidence of its malignancy. These features are characteristic of an adeno-carcinoma. Based on Mallory's classification, however, the neoplasm under consideration should be classified as a carcinoma.

As to the origin of the primary tumor, we can consider the oviduct, the mesentery and the liver as the probable organs. The kidneys, spleen, and ovaries can be eliminated because so far as could be determined macroscopically and microscopically no evidence of tumor formation in these organs is seen. The mesentery which is riddled with numerous minute tumor nodules might be taken as the possible origin of the primary tumor. But, since the mesentery is not lined with epithelium and from the fact that this tumor can originate only from pre-existing glands, this possibility is remote. The oviduct to which the largest nodule is attached might also be taken as the primary source of the tumor. However, the presence of glandular tissue consisting of numerous duct-like structures lined with simple cuboidal epithelium simulating adenomatous proliferation of bile ducts could not be derived from the oviduct. It is interesting to note that the liver shows this same adenomatous structures and it is very probable that this organ might have contained the primary tumor, deriving its origin from the epithelium of the bile duct. From the ducts, cords of epithelial cells must have given rise to the conglomerated minute nodules found closely attached to the visceral surface of the liver. Subsequent infiltrating growth must have given rise to the formation of the numerous tumor growths present on the small and large intestines, the proventriculus, the gizzard and the mesentery. The large pedunculated nodule (pl. 1, *a*) attached to the oviduct must have acquired its large size due to the fact that there is more space for development of the nodule at the posterior part of the abdominal cavity.

SUMMARY AND CONCLUSIONS

1. A carcinoma in a hen, extensively involving the external surface of the small and large intestines, the proventriculus, the visceral surface of the gizzard, liver, oviduct, and the mesentery, is described herein.
2. The primary tumor must have derived its origin from the epithelium of the bile duct since adenomas will copy more or less closely the structure of the original gland, which in this case is the liver.
3. Malignancy of the tumor, as evidenced by its extensive infiltration of most of the abdominal organs and the presence of numerous mitotic figures, must have been responsible for the death of the hen.

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A STUDY OF THE EFFICIENCY OF DIFFERENT MATERIALS FOR BAGGING TOBBACO FLOWERS[1]

MARCOS M. DE LA CRUZ

WITH FIFTEEN TEXT FIGURES

INTRODUCTION

Because the tobacco plant is subject to natural cross-pollination, bagging the flowers before they open in order to force self-pollination and induce inbreeding and the production of uniform plants is a subject of great importance to tobacco growers. In the Cagayan Valley where most of the Philippine tobacco is raised, bagging good mother plants, with possibly few exceptions, is not practiced. As a consequence of not bagging, the Philippine tobacco fields are mixtures of different types, these mixtures being mostly genetic in nature. Heterogeneity in a tobacco field is undesirable as it gives rise to a product of non-uniform quality and consequently of a lower market price.

In the Philippines, the majority of the tobacco farmers are not yet aware of the fact that cross-pollinated plants produce variable offspring. The government agents are educating these farmers to bag mother plants for seed purposes, but partly on account of the high cost of bagging material and the difficulty in securing paper or cheese-cloth bags which are ordinarily used in other countries for this purpose, the farmers find it hard to follow the agent's advice. This fact, together with the importance of uniform crops which require less expense in grading and often bring a higher price, makes it advisable to try by experiment to determine what cheap bagging materials can be substituted for those ordinarily used. Available literature shows no report of work along this line of investigation.

Object of the present work

The object of this work was to determine the efficiency of bagging materials for preventing crossing in tobacco.

Time and place of the present work

This experiment was conducted in the field near the Tobacco House, College of Agriculture, Los Baños. The experiment was performed from December 9, 1927 to July, 1928, a period of about 10 months.

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[1] Thesis presented for graduation, 1929, with the degree of Bachelor of Science in Agriculture from the College of Agriculture No. 293; Experiment Station contribution No. 609. Prepared in the Department of Agronomy under the direction of Dr. Nemesio B. Mendiola.

MATERIALS AND METHODS

Bagging materials used

There were fourteen kinds of bagging materials used in this work (see table 1).

Varieties of tobacco used

There were twenty-seven varieties used, seven of which were imported, the rest native. The plants were of the 1927-1928 crop. The varieties used are listed in table 2.

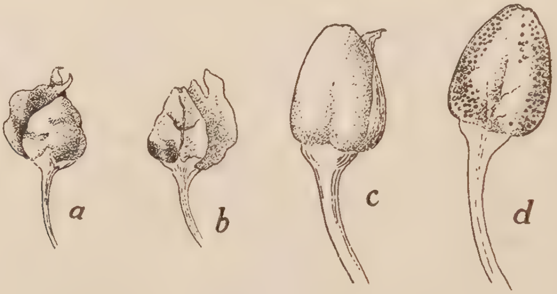

Fig. 1—Results of emasculation and bagging.
a, an undeveloped capsule from a flower which was emasculated and bagged
b, longitudinal section of capsule shown in *a*
c, a developed capsule from a flower which was emasculated and bagged
d, longitudinal section of a capsule shown in *c*

Plan of the work

The seedlings used in this study were obtained from the Tobacco Division of the Department of Agronomy, College of Agriculture. Transplanting began during the latter part of December and was continued to the early part of January. The seedlings were planted in rows distanced 70 centimeters each way. Each row was labeled by tying a celluloid tag to a strong peg at one end of the row. Cultivation, weeding, and worming were done often until the plants were harvested.

While the plants were still small, the materials for bagging were prepared. The bamboo splits for the frames of the bags were made. Leaves of the different materials were gathered and kept in the shade for about one-half day before the frames were covered with them. The bamboo frames in shape resembled fish traps; each had a diameter at the mouth of about 20 to 25 centimeters and length from the vertex to the mouth of about 30 to 35 centimeters. If the bamboo splits are ready, a man can make 30 to 40 frames in an hour. In covering the frames, little effort and not much intelligence are needed, but care must be taken to cover them thoroughly. The tobacco leaves were glued together and all small patches covered.

A net work of pieces of banana sheath was sometimes interwoven over these bags to make the leaves plastic and prevent the entrance of insects. The outer skin of the bamboo joints was removed and four small holes were made in each joint to admit air. The other materials were used in about the same way as the tobacco leaves except that they were not glued together.

As it was the object of this experiment to test the efficiency of the bagging materials, two separate investigations were performed simultaneously. One was to test the efficiency of the bagging materials in preventing cross-pollination; this was done by emasculating the flowers treated before they were bagged. The other investigation was to find whether selfed flowers developed normally inside the bag.

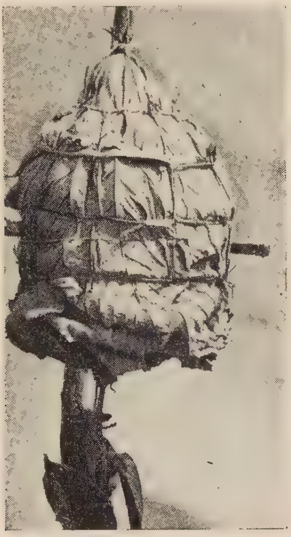

Fig. 2.—Dried *binonga* leaves (*Macaranga tanarius* Linn.) as bagging material.

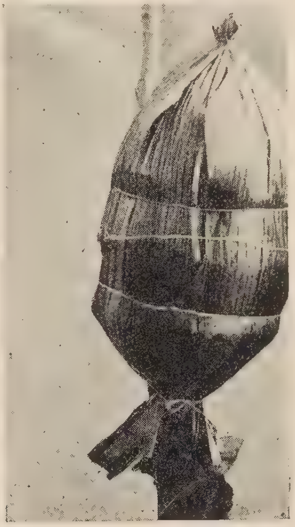

Fig. 3.—Dried banana sheath (*Musa sapientum* Linn.) as bagging material.

In bagging plants, all the upper leaves of the plant treated were trimmed and all bottom lateral branches of the flower cluster were removed. In the first experiment, flowers about to open and flowers which were not yet ready to be emasculated were removed, leaving five to twenty-two flowers which were about the same size. In these flowers the corolla was still a little longer than the calyx, but the selfed flowers were about to open. Flowers of this age were used so as to hasten the work. Emasculation was done by splitting the corolla and removing all the five anthers with the aid of a pair of scissors or forceps. Care was taken to remove all the anthers and not to injure the ovary and stigma.

As soon as the flowers were emasculated and perfectly cleaned, they were bagged. To minimize personal error, a tag bearing the number of flowers and the date when treated was put on each plant. A pole was driven into the ground near the plant. This pole supported the bags. Each bag was fastened with two pieces of stick tied to the pole to prevent the bag from moving. After from seven to twenty-two days the bags were removed, as at the end of this time the stigmas had withered and some undeveloped capsules had fallen. Records of the number of capsules left and those that developed were made. To determine if some developed, careful examination was made of the remaining capsules of the emasculated flowers. A developed capsule is hard to the touch, so is easily recognized. Capsules which developed were taken care of in the field until they were harvested.

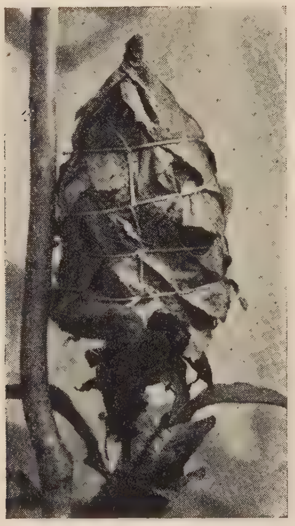

Fig. 4.—Dried *lumbang* leaves (*Aleurites moluccana* (Linn.) Wild) as bagging material.

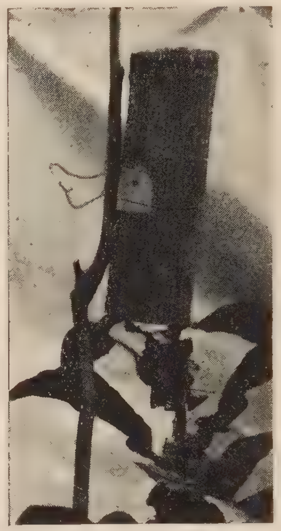

Fig. 5.—A stem of *boho* bamboo (*Schizostachyum lumampao* (Blanco) Merr.) as bagging material.

EXPERIMENTS AND RESULTS

On February 2, 1928, some plants began to flower and bagging was begun. Several plants in the field were left untreated to serve as sources of pollen for natural cross-pollination. Several trials at different times were made in testing the efficiency of each kind of bag. Plants treated were selected at random. Tables 3 to 16 present the results of bagging emasculated flowers.

Table 3 shows the results of using dried banana sheath. Not a single capsule developed and the efficiency of this bag may therefore be considered as 100 per cent, which is computed by dividing the number of capsules developed by the number of flowers treated, and multiplying the quotient by 100 per cent. This bag was good and the ease with which it can be handled is a point in its favor.

Table 4 shows the results from using bag made of banana leaves. The efficiency was 100 per cent. It was a good kind of bag.

Table 5 shows the results from using dried leaves of *bandera española*. This bag was also good and plastic. The efficiency was 100 per cent.

Table 6 gives the results from using *boho* bamboo. One of the flowers bagged developed. This bag was 99.59 per cent efficient.

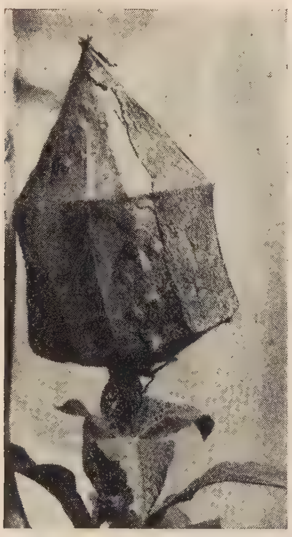

Fig. 6.—Dried tobacco leaves (*Nicotiana tabacum* Linn.) as bagging material.

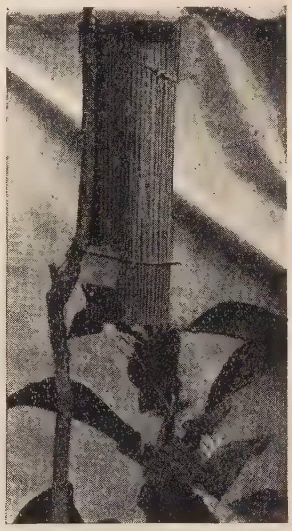

Fig. 7.—An ordinary bamboo joint (*Bambusa blumeana* Schultes f.) as bagging material.

Table 7 shows the results from using dried tobacco leaves. This material was 100 per cent efficient, but it was hard to handle as it blistered and cracked.

Table 8 contains the results from using dried *anahaw* leaves. The efficiency was 100 per cent. This bag was efficient and handy.

Table 9 shows the results from using *gabi* leaves. It had an efficiency of 100 per cent, but on rainy days it rotted, hence, was easily destroyed.

Table 10 gives the results from using edible canna leaves. This material had an efficiency of 100 per cent, but the bag broke about the middle of the day when used.

Table 11 shows the results from using ordinary bamboo joints. Two of the flowers developed from the same plant and the efficiency was only 99.20

per cent. The holes made for ventilation might have allowed contaminating pollen to get in.

Table 12 shows the results from using dried leaves of *tibig*. The efficiency was 100 per cent.

Table 13 shows the results from using *lumbang* leaves. Two flowers each from one plant developed, so the efficiency of this material was only 99.11 per cent.

Table 14 gives the results from using leaves of *castor beans*. There were three flowers that developed, two of which were from one plant. It had therefore an efficiency of 99.86 per cent only. Like the *gabi* leaves it had a tendency to rot on rainy days.

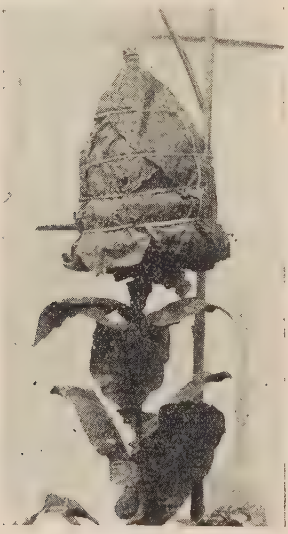

Fig. 8. — Dried *tibig* leaves (*Ficus nota* (Blanco) Merr.) as bagging material.

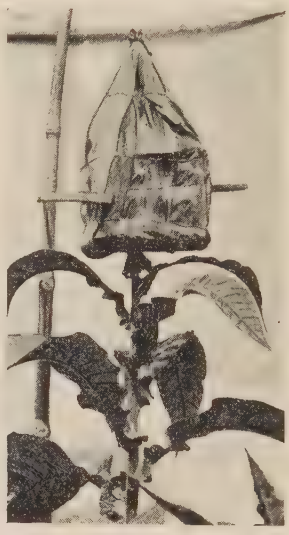

Fig. 9.—Dried edible canna leaves (*Canna edulis* K.G.) as bagging material.

Table 15 shows the results from using *darumaka* leaves. One capsule developed, hence this bag had 99.54 per cent efficiency.

Table 16 shows the results from using *dried binonga* leaves. It had a 100 per cent efficiency. This bag can be used for only a short time.

The results obtained from the selfed flowers are given in tables 17 to 30.

Table 31 gives the summary of results of both emasculated and selfed flowers and the efficiency of the bagging materials.

An attempt to find the percentage of developed capsules in open air was also made and the results are given in table 32. Observation of insects found about the flowers was also made; representatives were caught for measurement and identification.

Effort was made to germinate in the laboratory the seeds of developed capsules that were emasculated and representative seeds from selfed capsules. Care was taken not to mix seeds bagged with different kinds of bagging material. Seeds from capsules bagged with Manila paper were obtained from the Tobacco Seed House and used for control. The method used in germinating seeds was as follows: The seeds were placed in round, damp filter papers in petri dishes. These filter papers were divided into 72 squares by lining them with a hard pencil. With the aid of a pair of forceps, seeds were set in the squares, one square enclosing one seed. The petri dishes were covered and on top they were labeled with a glass pencil. These petri dishes were set aside for eight to ten days and at intervals of two days the filter papers were moistened. The results of this trial were unsatisfactory as the media favored the growth of molds. The second method was similar to the first, but the filter paper, the petri dishes, and the water used were sterilized. This method was successful and the number of germinated seeds were re-examined after eight to ten days had elapsed. The results of this experiment are presented in tables 33 and 34.

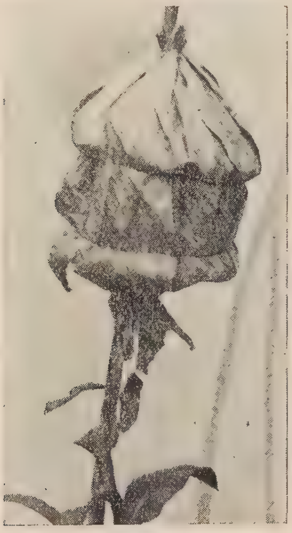

Fig. 10.—Dried *bandera española* leaves (*Canna indica* Linn.) as bagging material.

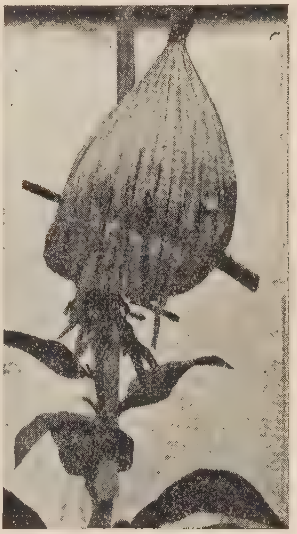

Fig. 11.—Dried *anahaw* leaves (*Livistonia rotundifolia* Mart.) as bagging material.

Table 31 presents the percentages of germinated seeds that had been selfed, including the control. Table 32 presents the percentages of germination of seeds that had been emasculated and bagged.

DISCUSSION OF RESULTS

Whether the use of the bagging materials utilized in this experiment is economical and practical is the question to be considered first. Under conditions where labor is cheap and communication is rather hard they may be considered economical and practical. For example in the Cagayan Valley, the materials can be obtained with little difficulty, and, as stated elsewhere, in the making of the bag little effort and intelligence are needed; the important thing being that care be taken to cover the frames thoroughly. A boy or girl about 10 or 12 years old or a man or woman should be able easily to make one hundred bags in a day. Taking then the mean of the average daily wage separately in the Cagayan Valley and computing the cost of one bag from this item, it will cost less than one centavo a bag,[2] while the cost of paper and cheese cloth bags, according to reliable information, are five pesos a thousand or one half centavo a bag. There seems little difference between the cost of one paper bag and one made of these materials, but taking into account the cost of transportation into the Cagayan Valley, the cost of the bagging material under question is less. Furthermore, these paper bags are sold only by the thousand, a quantity which the average farmer can not afford to buy. Moreover, as farmers usually have some idle hours, they can spend them in collecting materials for bags.

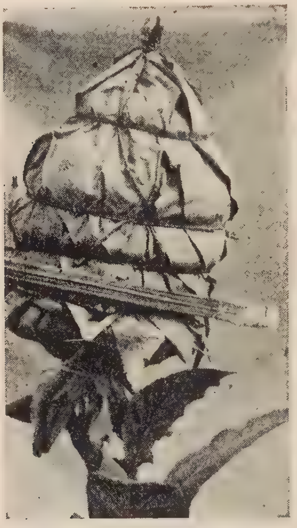

Fig. 12. — Dried *darumaka* leaves (*Donax cannaeformis* (Forst. f) Schunn.) as bagging material.

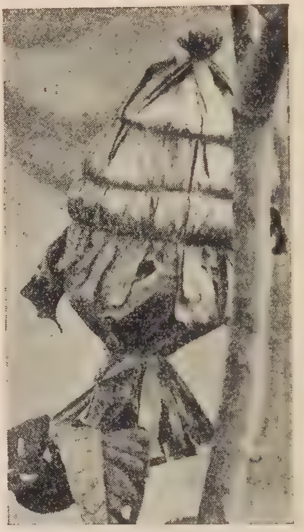

Fig. 13.—Dried banana leaves (*Musa sapientum* Linn.) as bagging material.

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[2] Philippine Bureau of Commerce and Industry Bull. No. 9, 1926.

Table 3 shows the efficiency of dried banana sheath in preventing cross-pollination of tobacco flowers. The efficiency as seen from this table is 100 per cent. This means that not a single treated flower developed. All the emasculated flowers were stunted, wrinkled, and fell easily. Several examinations were made of the undeveloped capsules but they did not contain a single seed. This condition is shown in fig. 1 *a* and *b*. From such results, it is evident that dried banana sheath is fully efficient as inbreeding material. The ease of obtaining and handling it are additional points in its favor.

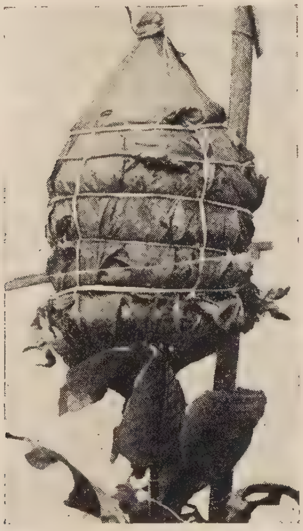

Fig. 14.—Dried castor bean leaves (*Ricinus communis* Linn.) as bagging material.

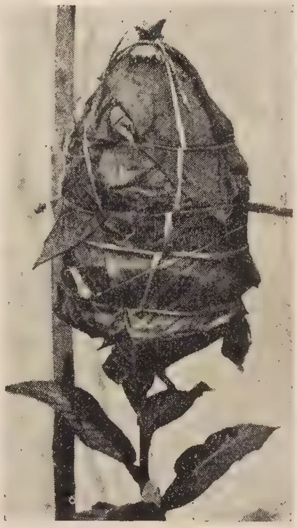

Fig. 15.—*Gabi* leaves (*Colocasia esculentum* (Linn.) Schott.) as bagging material.

The efficiency of dried banana leaves in preventing cross-pollination is given in table 4. As with the banana sheath, there was no single flower that developed. The efficiency was 100 per cent. This bag was also easy to use and to handle.

In the case of the dried leaves of *bandera española* the efficiency was also 100 per cent. (See table 5). The ease of handling and its plasticity are points which should be credited to it.

Table 6 which presents the efficiency of *boho bamboo* as a bagging material for preventing cross-pollination shows a very interesting case, for one pod developed. This pod was from a plant of the Hybrids 6F$_7$ (Connecticut Havanan ♂ × Repollo ♀). It was a well developed capsule and contained numerous viable seeds. Fig. 1, *c*, represents the developed capsule and fig. 1, *d*, represents the longitudinal view. The writer does not know positively just what caused the development of this pod, however, he does not claim emasculation was done with absolute thoroughness although it was quite thorough. It is possible that not all anthers were removed; or the holes made in the tube for air circulation served as a passage for insects which might have caused cross-pollination; or the seeds might have developed parthenogenetically. According to Goodspeed (1915), the occurrence of viable seeds of *Nicotiana tabacum* L. in Cuba from flowers that had been emasculated by picking off the anthers near the top of the filaments, castrated in bud plus the pinching off with the forceps of the stigma at the very top of the style, or mutilated by pinching off the stigma in the bud without the removal of the anthers may be explained on parthenogenetic grounds, although it has never been reported that there is parthenogenesis in tobacco in the Philippines.

Table 7 shows the efficiency of dried tobacco leaves. Although the efficiency was 100 per cent it does not compare favorably with other bagging materials as it has some bad qualities. In the first place, it was not durable for it blistered and cracked on hot and windy days. A bird alighting on it was enough to break it and on rainy days it remained very wet. It was for this last reason that only a few flowers were treated, for one bag could scarcely be kept whole or unbroken long enough to catch the flowers before they withered and dried.

Table 8 gives the results of using dried *anahaw* leaves. The efficiency, as seen in the table, was 100 per cent. This bag was handy, very plastic, good and easy to use.

The efficiency of the dried *gabi* leaves was 100 per cent, but on account of the tendency of the leaves to rot on rainy days and their softness on hot days, this bag was hard to use. The results of the use of this bag are given in table 9.

As seen from table 10, the *canna* leaves had an efficiency of 100 per cent. Like the *bandera española*, they were plastic and easy to use.

Another case of emasculated flowers which happened to develop is found in table 11. It occurred on variety 65-Havanensis. Because of this case the efficiency of the bamboo tube was only 99.20 per cent. The explanation for the development of the pod is probably similar to that given in the case of *boho* bamboo.

Table 12 gives the data obtained from using dried *tibig* leaves. This bag had also a 100 per cent efficiency. It was also a good bag.

Tables 13, 14, and 15 give cases where developed capsules were found. The bagging materials used were *lumbang* leaves, dried *darumaka* leaves, and dried *castor bean* leaves. There was one capsule from Texas Cuban variety that developed under the dried *lumbang* leaves. In the case of castor bean leaves, three pods developed from two plants. They came from the same variety, Connecticut Havana, while that which developed under *darumaka* leaves arose from Texas Cuban. Owing to this development the lumbang leaves had only 99.11 per cent; dried *darumaka* leaves, 99.86 per cent and *castor* bean leaves 99.54 per cent efficiency. It is interesting to note that cases of development of pods always occurred in imported varieties and this may suggest an important point to the tobacco breeder.

Table 16 shows the efficiency of dried *binoñga* leaves. This bag was also good for the efficiency was 100 per cent.

Summarising results thus far obtained from bagging emasculated flowers with different bagging materials, as shown in table 31, it may be said that five kinds are considered inefficient in preventing cross-pollination. It is of course impossible to lay down facts that these five bagging materials, namely, the *boho* bamboo, bamboo tubes, dried *lumbang* leaves, dried *darumaka* leaves, and dried *castor* bean leaves, were inefficient but with the rest of the bagging materials, the dried banana sheath, the dried banana leaves, the dried *bandera española* leaves, the dried *anahaw* leaves, dried tobacco leaves, the dried edible canna leaves, the dry *tibig* leaves, the dried *gabi* leaves and the dried *binoñga* leaves, it may be stated that under Los Baños conditions they were efficient in preventing cross-pollination. They were all 100 per cent efficient (see table 29) in preventing cross-pollination, although dried tobacco leaves blistered and cracked and dried *gabi* leaves rotted during the rainy season.

In connection with the subject of efficiency of materials for preventing pollen grains from outside source getting in, it is worth while to consider the insects observed as possible pollinators. Specimens of different species of insects visiting tobacco flowers were measured. Likewise, they were examined for presence of pollen grains. Among the commonest visitor was *Trigona* sp. (Apidae, Hymenoptera). This measured four millimeters long and two millimeters wide (with folded wings). This bee is related to the honey bee. Another insect visitor, though a rare one, was *Papilio* sp. (Papilionidae Lepidoptera) which measured 2.6 millimeters long (excluding antennae), and 97 millimeters wide (including wings). Pollen grains were found on the antennae of this insect. *Dicyphus nicotianae* Kon. (Capsidae, Hemiptera) was an insect present among the stems, leaves, and in the corolla of the flowers. Although they were not found to carry pollen, they probably cause cross-pollination because they can fly from plant to plant. This insect measured 3.5 millimeters in length and 1 millimeter in width. In the Kiel Botanic Garden, Knuth (1909) observed among tobacco flowers a hawkmoth, *Macroglossa stellatarum* Linn. He further observed in the Garden of the Kiel Oberkealschule several honey bees creeping into the flowers and remaining there for some seconds, so that they probably were able to suck nectar and to cause cross-pollination. These bees are perhaps related to the bees caught in the present work. From the measurement of the insects caught it is very plain that *Trigona* sp. and *Dicyphus nicotianae* were able to pass through the small holes of the tubes and may have caused pollination of the flowers. But in the case of the bags made out of leaves, the frames were thoroughly covered, so they had no chance to enter, unless they passed through the space between the overlapping parts of the leaves; this would be with difficulty because a network of small pieces of banana sheath were interwoven on the bags to make them plastic.

The results obtained in bagging unemasculated flowers are shown in tables 17 to 30. All bagging materials were fairly good and their mean efficiency is given in table 31. The efficiency ranges from 75.71 per cent up to 88.58 per cent. A control was conducted by allowing flowers to produce pods without bagging. The mean average obtained for the control was 80.43 per cent (see table 32). These figures show then that flowers selfed by using the different bagging materials were able to develop.

Table 33 gives the results of laboratory germination tests of the seeds from pods arising from emasculated flowers. They gave a fairly high germination accompanied with very uniform growth of the seedlings. The percentage of germination (see table 34) probably depends on the kind of the variety and the amount of water applied during germination. However, the germination was fairly uniform. Likewise the seeds from pods of unemasculated flowers germinated fairly well and more or less uniformly. Four days after setting them, they germinated with good stand and produced healthy seedlings. The control used, bagged with paper bag, had 80.55 per cent which was approximately the average of all the percentages of germination found. According to Shamel (1906), seed saved under bag is larger, heavier, lighter in color, freer from mold and has stronger viability than seed developed unbagged. This report was confirmed in this work for the percentages of germination recorded were all high.

SUMMARY OF CONCLUSIONS

1. Five bagging materials among the fourteen tested, namely, stem of *boho* bamboo (*Schizostachyum lumampao* (Blanco) Merr.), bamboo tubes (*Bambusa blumeana* Schultes f.), dried *lumbang* leaves (*Aleurites moluccana* Willd.), dried *darumaka* leaves (*Donax cannaeformis* (Forst. f.) K. Schum.), and dried castor bean leaves (*Ricinus communis* Linn.) were found inefficient in preventing cross-pollination. The rest were efficient in preventing cross-pollination and all were good, except dried tobacco leaves (*Nicotiana tabacum* Linn.) which blistered and cracked on hot days, and *gabi* leaves (*Colocasia esculentum* (Linn.) Schott) which rotted on rainy days.

2. Capsules developed normally inside the bagging materials and seeds produced under these bagging materials germinated with high percentage of germination.

3. Capsules which were developed from emasculated flowers always came from imported varieties.

4. The bagging materials tested are economical and practical to use. This should be found true in places where the materials are abundant and labor is cheap, and in places where transportation facilities are not good, as in Cagayan Valley.

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TABLE 1

Bagging materials used

NAME OF BAGGING MATERIALS	SCIENTIFIC NAMES	VARIETY AND COMMON NAMES
Banana sheath	*Musa sapientum* Linn.	Saba
Banana leaves	*Musa sapientum* Linn.	Saba
Leaves of canna	*Canna indica* Linn.	Bandera española
Boho bamboo	*Schizostachyum lumampao* (Blanco) Merr.	Boho
Tobacco leaves	*Nicotiana tabacum* Linn.	Different varieties
Anahaw leaves	*Livistona rotundifolia* (Lam.) Mart.	Anahaw
Gabi leaves	*Colocasia esculentum* (Linn.) Schott.	Gabi
Edible canna	*Canna edulis* K. G.	Edible canna
Bamboo joints	*Bambusa blumeana* Schultes f.	Cawayan
Tibig leaves	*Ficus nota* (Blanco) Merr.	Tibig
Lumbang leaves	*Aleurites moluccana* Willd.	Lumbang
Binoñga leaves	*Macaranga tanarius* (Linn.) Muell.-Arg.	Binoñga
Darumaka leaves	*Donax cannaeformis* (Forst. f.) K. Schum.	Darumaka
Castor leaves	*Ricinus communis* Linn.	Tangan-tangan

TABLE 2

Tobacco varieties used

COLLEGE NUMBER	VARIETY NAME
Imported:	
Hybrid No. 1	Hybrid No. 1 (Imported Gold Leaf 7808 ♂×Repollo, 9976 ♀
Hybrid 6F_7	Hybrid 6F_7 (Conn. Havana ♂×Repollo ♀
Hybrid 7F_7	Hybrid 7F_7 (Conn. Broad Leaf ♂×Dammao Broad Leaf ♀
3156	Texas Cuban
4828	Conn. Havana
18567F_2	65-Havanensis
Native:	
2656F_6	Tirona Hybrid (Conn. Havana×Cagayan)
7891	Romero
9975	Dammao Broad Leaf
9976	Repollo
17097	San Antonio
17227	San Juan Batec
17296	Romero
17300	Pampano
17305	Angadanan
17319	Bonanza
18546F_2	Bamcang
18548F_2	Repollo mixed with Pampano and Espada
18549F_2	Catabacuan or Capigued Bacalao
18550F_2	Camarugui
18551F_2	Bacalao or Espada
18552F_2	Alofug
18554F_2	Catabacuan or Barung
18555F_2	Romero
18556F_2	Morada or Catabacuan
18560F_2	Bohia
18561F_2	12 Pampano No. 1
18563F_2	18-Romero
18564F_2	10 Repollo
18566F_2	Repollo mixed with Espada
18568F_2	40-Espada (SP No. 2)
18569F_2	43 Espada (SP No. 1)
18570F_2	6 Pampano No. 2

TABLE 3

Results of bagging emasculated tobacco flowers with dried banana sheaths

DATE OF EMASCULATION AND BAGGING	NUMBER OF FLOWERS BAGGED	DATE OF REMOVAL OF BAGGING MATERIALS	NUMBER OF CAPSULES LEFT	NUMBER OF DEVELOPED CAPSULES	PERCENTAGE OF DEVELOPED CAPSULES
1928		1928			
Feb. 2	7	Feb. 13	none	0	0
" 8	8	" 16	5	0	0
" 9	7	" 20	5	0	0
" 9	9	" 22	none	0	0
" 9	6	" 23	6	0	0
" 18	12	" 27	12	0	0
" 22	15	March 1	14	0	0
" 23	13	" 11	none	0	0
" 28	7	" 11	6	0	0
March 1	9	" 11	8	0	0
" 11	14	" 20	7	0	0
" 11	11	" 20	3	0	0
" 11	10	" 20	6	0	0
" 16	5	" 26	none	0	0
" 20	13	" 28	10	0	0
" 20	7	April 1	4	0	0
" 20	14	" 1	10	0	0
" 22	10	" 1	3	0	0
" 22	13	" 1	9	0	0
" 26	12	" 5	7	0	0
" 28	5	" 5	1	0	0
April 5	8	" 12	3	0	0
" 5	10	" 12	6	0	0
" 6	8	" 12	5	0	0
" 12	6	" 17	2	0	0
" 12	11	" 17	7	0	0

Efficiency = 100 per cent

TABLE 4

Results of bagging emasculated tobacco flowers with dried banana leaves

DATE OF EMASCULATION AND BAGGING	NUMBER OF FLOWERS BAGGED	DATE OF REMOVAL OF BAGGING MATERIALS	NUMBER OF CAPSULES LEFT	NUMBER OF DEVELOPED CAPSULES	PERCENTAGE OF DEVELOPED CAPSULES
1928		1928			
Feb. 7	8	Feb. 20	2	0	0
" 12	6	" 22	none	0	0
" 20	15	March 1	3	0	0
" 22	12	" 1	5	0	0
" 27	11	" 11	none	0	0
" 28	8	" 11	none	0	0
March 1	9	" 11	1	0	0
" 11	7	" 20	none	0	0
" 11	13	" 20	6	0	0
" 11	5	" 20	3	0	0
" 15	12	" 26	none	0	0
" 15	14	" 26	6	0	0
" 20	13	" 28	11	0	0
" 20	10	" 28	none	0	0
" 20	7	" 28	none	0	0
" 24	12	April 1	9	0	0
" 26	8	" 5	1	0	0
" 26	5	" 5	none	0	0
" 28	15	" 5	10	0	0
" 28	7	" 5	3	0	0
April 5	10	" 12	9	0	0
" 5	10	" 12	6	0	0
" 5	16	" 12	12	0	0
" 12	7	" 17	3	0	0
" 12	8	" 17	5	0	0

Efficiency = 100 per cent

TABLE 5

Results of bagging emasculated tobacco flowers with dried bandera española leaves

DATE OF EMASCULATION AND BAGGING	NUMBER OF FLOWERS BAGGED	DATE OF REMOVAL OF BAGGING MATERIALS	NUMBER OF CAPSULES LEFT	NUMBER OF DEVELOPED CAPSULES	PERCENTAGE OF DEVELOPED CAPSULES
1928		1928			
Feb. 2	6	Feb. 13	6	0	0
“ 11	9	“ 22	9	0	0
“ 11	6	“ 23	2	0	0
“ 22	13	March 1	5	0	0
“ 22	15	“ 1	10	0	0
“ 22	20	“ 1	12	0	0
“ 22	17	“ 1	5	0	0
“ 23	9	“ 11	8	0	0
March 1	6	“ 11	6	0	0
“ 1	11	“ 11	2	0	0
“ 2	10	“ 11	5	0	0
“ 11	10	“ 20	none	0	0
“ 11	8	“ 20	2	0	0
“ 11	11	“ 20	6	0	0
“ 11	10	“ 20	9	0	0
“ 12	9	“ 20	none	0	0
“ 12	5	“ 20	4	0	0
“ 12	12	“ 20	3	0	0
“ 20	6	“ 28	none	0	0
“ 20	10	“ 28	5	0	0
“ 20	5	“ 28	5	0	0
“ 26	9	April 5	4	0	0
“ 28	16	“ 5	none	0	0
“ 28	11	“ 5	none	0	0
April 1	8	“ 8	none	0	0
“ 5	12	“ 12	4	0	0
“ 5	9	“ 12	4	0	0
“ 5	8	“ 12	7	0	0
“ 5	13	“ 12	8	0	0
“ 12	8	“ 17	8	0	0

Efficiency = 100 per cent

TABLE 6

Results of bagging emasculated tobacco flowers with boho bamboo

DATE OF EMASCULATION AND BAGGING	NUMBER OF FLOWERS BAGGED	DATE OF REMOVAL OF BAGGING MATERIALS	NUMBER OF CAPSULES LEFT	NUMBER OF DEVELOPED CAPSULES	PERCENTAGE OF DEVELOPED CAPSULES
1928		1928			
Feb. 5	8	Feb. 16	8	0	0
" 6	10	" 16	2	0	0
" 22	7	" 16	none	0	0
" 22	12	March 1	10	0	0
" 23	9	" 1	5	0	0
" 27	7	" 1	6	0	0
March 2	13	" 11	2	0	0
" 2	8	" 11	1	0	0
" 11	5	" 11	3	1	.41
" 11	15	" 20	7	0	0
" 11	5	" 20	none	0	0
" 14	10	" 20	9	0	0
" 14	9	" 22	4	0	0
" 14	11	" 22	7	0	0
" 15	10	" 28	7	0	0
" 20	6	" 29	none	0	0
" 20	11	" 29	7	0	0
" 22	12	" 29	4	0	0
" 22	7	" 29	5	0	0
" 28	11	April 5	none	0	0
" 29	8	" 5	8	0	0
" 29	4	" 5	none	0	0
" 29	10	" 5	3	0	0
April 5	10	" 12	none	0	0
" 5	8	" 12	2	0	0
" 5	7	" 12	none	0	0
" 8	6	" 12	1	0	0

Efficiency = 99.59 per cent

TABLE 7

Results of bagging emasculated tobacco flowers with dried tobacco leaves

DATE OF EMASCULATION AND BAGGING	NUMBER OF FLOWERS BAGGED	DATE OF REMOVAL OF BAGGING MATERIALS	NUMBER OF CAPSULES LEFT	NUMBER OF DEVELOPED CAPSULES	PERCENTAGE OF DEVELOPED CAPSULES
1928		1928			
Feb. 2	6	Feb. 13	4	0	0
" 9	6	" 20	1	0	0
" 18	8	" 19	none	0	0
" 19	5	" 27	none	0	0
March 1	12	March 11	8	0	0
" 1	9	" 11	3	0	0
" 11	13	" 20	10	0	0
" 11	8	" 20	5	0	0
" 11	6	" 20	none	0	0
" 12	10	" 20	4	0	0
" 22	5	" 29	none	0	0
" 22	7	" 29	3	0	0
" 22	12	" 29	10	0	0
" 28	5	April 5	5	0	0
" 29	6	" 5	2	0	0
" 30	11	" 5	5	0	0
April 5	14	" 12	6	0	0
" 5	7	" 12	1	0	0

Efficiency = 100 per cent

TABLE 8

Results of bagging emasculated tobacco flowers with dried anahaw leaves

DATE OF EMASCULATION AND BAGGING	NUMBER OF FLOWERS BAGGED	DATE OF REMOVAL OF BAGGING MATERIALS	NUMBER OF CAPSULES LEFT	NUMBER OF DEVELOPED CAPSULES	PERCENTAGE OF DEVELOPED CAPSULES
1928		1928			
Feb. 2	11	Feb. 13	2	0	0
" 8	6	" 16	6	0	0
" 8	11	" 20	7	0	0
" 9	7	" 22	none	0	0
" 9	6	" 23	6	0	0
" 11	9	" 22	2	0	0
" 18	13	March 1	10	0	0
" 18	15	" 1	14	0	0
" 22	10	" 1	7	0	0
" 22	8	" 1	8	0	0
" 25	10	" 11	5	0	0
" 25	9	" 11	7	0	0
" 27	10	" 11	none	0	0
March 1	9	" 11	5	0	0
" 1	9	" 11	9	0	0
" 1	8	" 11	6	0	0
" 11	10	" 20	2	0	0
" 11	12	" 20	6	0	0
" 11	10	" 20	none	0	0
" 11	9	" 28	none	0	0
" 20	14	April 1	7	0	0
" 20	10	" 1	9	0	0
" 20	11	" 1	3	0	0
" 28	6	" 5	none	0	0
April 1	12	" 8	7	0	0
" 5	12	" 12	4	0	0
" 5	9	" 12	6	0	0
" 5	16	" 12	10	0	0
" 5	16	" 12	4	0	0
" 6	7	" 12	1	0	0
" 8	10	" 17	none	0	0
" 8	6	" 17	6	0	0
" 12	5	" 17	3	0	0

Efficiency = 100 per cent

TABLE 9

Results of bagging emasculated tobacco flowers with gabi leaves

DATE OF EMASCULATION AND BAGGING	NUMBER OF FLOWERS BAGGED	DATE OF REMOVAL OF BAGGING MATERIALS	NUMBER OF CAPSULES LEFT	NUMBER OF DEVELOPED CAPSULES	PERCENTAGE OF DEVELOPED CAPSULES
1928		1928			
Feb. 9	9	Feb. 16	1	0	0
" 14	12	" 27	11	0	0
" 15	7	" 27	7	0	0
" 15	9	March 1	none	0	0
" 15	10	" 1	9	0	0
March 1	13	" 11	5	0	0
" 1	9	" 11	8	0	0
" 1	8	" 11	3	0	0
" 11	15	" 20	6	0	0
" 11	12	" 20	4	0	0
" 11	13	" 20	12	0	0
" 14	14	" 22	none	0	0
" 20	15	" 28	13	0	0
" 20	11	" 28	7	0	0
" 20	5	" 28	none	0	0
" 28	7	April 5	5	0	0
" 28	17	" 5	4	0	0
" 28	14	" 5	10	0	0
April 5	19	" 12	3	0	0
" 12	7	" 17	1	0	0

Efficiency = 100 per cent

TABLE 10

Results of bagging emasculated tobacco flowers with dried leaves of edible canna

DATE OF EMASCULATION AND BAGGING	NUMBER OF FLOWERS BAGGED	DATE OF REMOVAL OF BAGGING MATERIALS	NUMBER OF CAPSULES LEFT	NUMBER OF DEVELOPED CAPSULES	PERCENTAGE OF DEVELOPED CAPSULES
1928		1928			
Feb. 2	5	Feb. 13	none	0	0
" 11	4	" 22	none	0	0
" 11	8	" 23	none	0	0
" 20	11	" 27	none	0	0
" 23	8	March 11	3	0	0
March 12	11	" 20	7	0	0
" 12	13	" 20	5	0	0
" 12	9	" 20	9	0	0
" 14	13	" 22	13	0	0
" 14	10	" 22	3	0	0
" 15	13	" 26	none	0	0
" 20	15	" 28	10	0	0
" 20	12	" 28	10	0	0
" 22	15	April 1	7	0	0
" 22	14	" 1	none	0	0
" 26	11	" 5	5	0	0
" 28	6	" 5	3	0	0
" 28	9	" 5	none	0	0
April 1	11	" 8	9	0	0
" 5	7	" 12	4	0	0
" 5	13	" 12	7	0	0
" 5	11	" 12	6	0	0
" 8	9	" 17	3	0	0
" 12	7	" 17	6	0	0
" 12	5	" 17	5	0	0

Efficiency = 100 per cent

TABLE 11

Results of bagging emasculated tobacco flowers with ordinary bamboo joints

DATE OF EMASCULATION AND BAGGING	NUMBER OF FLOWERS BAGGED	DATE OF REMOVAL OF BAGGING MATERIALS	NUMBER OF CAPSULES LEFT	NUMBER OF DEVELOPED CAPSULES	PERCENTAGE OF DEVELOPED CAPSULES
1928		1928			
Feb. 5	7	Feb. 16	7	0	0
" 5	5	" 16	5	0	0
" 6	6	" 16	6	0	0
" 23	13	March 11	2	0	0
" 27	9	" 11	5	0	0
" 28	6	" 11	2	0	0
March 12	5	" 20	none	0	0
" 12	12	" 20	8	0	0
" 12	8	" 20	4	0	0
" 14	8	" 21	1	0	0
" 15	15	" 24	3	0	0
" 15	11	" 24	11	0	0
" 15	6	" 26	none	0	0
" 20	4	" 28	4	0	0
" 20	14	" 28	12	0	0
" 20	10	" 28	6	0	0
" 24	11	April 1	4	0	0
" 24	8	" 1	7	0	0
" 28	5	" 5	none	0	0
" 28	15	" 6	3	2	.8
" 29	6	" 6	6	0	0
" 29	10	" 6	7	0	0
" 29	12	" 6	4	0	0
April 5	11	" 12	4	0	0
" 5	7	" 12	1	0	0
" 5	9	" 12	9	0	0
" 6	9	" 12	8	0	0
" 6	6	" 12	5	0	0

Efficiency = 99.20 per cent

TABLE 12

Results of bagging emasculated tobacco flowers with dried tibig leaves

DATE OF EMASCULATION AND BAGGING	NUMBER OF FLOWERS BAGGED	DATE OF REMOVAL OF BAGGING MATERIALS	NUMBER OF CAPSULES LEFT	NUMBER OF DEVELOPED CAPSULES	PERCENTAGE OF DEVELOPED CAPSULES
1928		1928			
Feb. 11	6	Feb. 22	6	0	0
“ 12	9	“ 19	none	0	0
“ 18	9	“ 27	7	0	0
“ 18	12	“ 27	4	0	0
“ 19	8	“ 27	4	0	0
“ 19	7	March 1	none	0	0
“ 27	9	“ 11	none	0	0
“ 27	10	“ 11	none	0	0
“ 27	8	“ 11	none	0	0
March 1	8	“ 11	1	0	0
“ 11	9	“ 20	none	0	0
“ 11	13	“ 20	13	0	0
“ 14	15	“ 22	10	0	0
“ 20	9	“ 28	7	0	0
“ 20	13	“ 28	12	0	0
“ 22	17	April 1	10	0	0
“ 28	12	“ 5	7	0	0
“ 28	5	“ 5	none	0	0
April 1	7	“ 8	3	0	0
“ 1	12	“ 8	7	0	0
“ 1	6	“ 8	4	0	0
“ 5	7	“ 12	none	0	0
“ 6	10	“ 12	6	0	0
“ 6	8	“ 12	none	0	0
“ 8	13	“ 15	5	0	0
“ 8	9	“ 15	none	0	0
“ 8	6	“ 17	2	0	0
“ 12	8	“ 17	5	0	0

Efficiency = 100 per cent

TABLE 13

Results of bagging emasculated tobacco flowers with dried lumbang leaves

DATE OF EMASCULATION AND BAGGING	NUMBER OF FLOWERS BAGGED	DATE OF REMOVAL OF BAGGING MATERIALS	NUMBER OF CAPSULES LEFT	NUMBER OF DEVELOPED CAPSULES	PERCENTAGE OF DEVELOPED CAPSULES
1928		1928			
Feb. 6	7	Feb. 20	1	0	0
" 11	8	" 19	1	0	0
" 11	9	" 22	none	0	0
" 11	5	" 22	2	0	0
" 11	8	" 23	7	1	.44
" 18	13	March 1	10	0	0
" 20	12	" 1	4	0	0
" 27	9	" 11	5	0	0
" 27	6	" 11	1	0	0
" 27	4	" 11	3	0	0
" 27	9	" 11	1	1	.44
March 1	5	" 11	none	0	0
" 1	6	" 11	5	0	0
" 11	10	" 20	10	0	0
" 11	7	" 20	none	0	0
" 11	15	" 20	11	0	0
" 11	10	" 20	4	0	0
" 20	12	" 28	7	0	0
" 20	11	" 28	9	9	0
" 20	17	" 28	10	0	0
" 29	5	April 6	5	0	0
April 6	7	" 12	0	0	0
" 6	13	" 12	0	0	0

Efficiency = 99.11 per cent

TABLE 14

Results of bagging emasculated tobacco flowers with dried leaves of castor beans

DATE OF EMASCULATION AND BAGGING	NUMBER OF FLOWERS BAGGED	DATE OF REMOVAL OF BAGGING MATERIALS	NUMBER OF CAPSULES LEFT	NUMBER OF DEVELOPED CAPSULES	PERCENTAGE OF DEVELOPED CAPSULES
1928		1928			
Feb. 22	10	March 1	8	1	.45
“ 22	6	“ 1	2	2	.96
“ 22	7	“ 11	7	0	0
March 1	10	“ 11	6	0	0
“ 2	12	“ 11	none	0	0
“ 2	9	“ 20	3	0	0
“ 11	11	“ 20	10	0	0
“ 11	8	“ 24	4	0	0
“ 15	13	“ 24	11	0	0
“ 15	12	“ 28	6	0	0
“ 20	10	“ 28	11	0	0
“ 20	15	April 1	7	0	0
“ 24	12	“ 5	8	0	0
“ 24	11	“ 1	4	0	0
“ 28	6	“ 5	4	0	0
“ 28	8	“ 5	2	0	0
April 1	12	“ 8	7	0	0
“ 1	7	“ 8	3	0	0
“ 1	15	“ 8	11	0	0
“ 5	9	“ 12	2	0	0
“ 6	6	“ 15	6	0	0

Efficiency = 99.86 per cent

TABLE 15

Results of bagging emasculated tobacco flowers with dried darumaka leaves

DATE OF EMASCULATION AND BAGGING	NUMBER OF FLOWERS BAGGED	DATE OF REMOVAL OF BAGGING MATERIALS	NUMBER OF CAPSULES LEFT	NUMBER OF DEVELOPED CAPSULES	PERCENTAGE OF DEVELOPED CAPSULES
1928		1928			
Feb. 5	12	Feb. 19	none	0	0
" 9	6	" 20	2	0	0
" 11	5	" 22	none	0	0
" 11	6	" 22	none	0	0
" 19	14	" 27	14	1	.46
" 22	13	March 1	9	0	0
" 22	12	" 1	5	0	0
" 22	10	" 1	1	0	0
" 27	7	" 11	2	0	0
" 28	9	" 11	5	0	0
March 1	8	" 11	2	0	0
" 1	6	" 11	none	0	0
" 11	7	" 20	none	0	0
" 11	8	" 20	6	0	0
" 11	8	" 20	2	0	0
" 20	9	" 28	none	0	0
" 20	13	" 28	5	0	0
" 20	15	" 28	13	0	0
" 29	11	April 5	4	0	0
April 5	9	" 12	9	0	0
" 5	5	" 12	4	0	0
" 5	10	" 12	5	0	0
" 6	7	" 12	none	0	0
" 12	6	" 17	5	0	0

Efficiency = 99.54 per cent

TABLE 16

Results of bagging emasculated tobacco flowers with dried binonga leaves

DATE OF EMASCULATION AND BAGGING	NUMBER OF FLOWERS BAGGED	DATE OF REMOVAL OF BAGGING MATERIALS	NUMBER OF CAPSULES LEFT	NUMBER OF DEVELOPED CAPSULES	PERCENTAGE OF DEVELOPED CAPSULES
1928		1928			
Feb. 8	6	Feb. 16	6	0	0
" 8	10	" 16	8	0	0
" 8	6	" 16	6	0	0
" 11	8	" 19	2	0	0
" 11	4	" 22	1	0	0
" 28	10	March 11	7	0	0
" 28	10	" 11	2	0	0
March 11	13	" 20	none	0	0
" 11	12	" 20	3	0	0
" 11	11	" 20	7	0	0
" 14	15	" 22	10	0	0
" 14	11	" 22	11	0	0
" 20	16	" 28	15	0	0
" 20	10	" 28	9	0	0
" 20	5	" 28	none	0	0
" 22	18	" 29	13	0	0
" 22	12	" 29	10	0	0
" 28	7	April 5	1	0	0
" 28	9	" 5	5	0	0
April 5	10	" 12	4	0	0
" 5	7	" 12	6	0	0
" 5	7	" 12	5	0	0

Efficiency = 100 per cent

TABLE 17

Results of bagging unemasculated tobacco flowers with dried banana sheath

DATE OF BAGGING	NUMBER OF FLOWERS BAGGED	DATE OF REMOVAL OF BAGGING MATERIALS	NUMBER OF CAPSULES LEFT	NUMBER OF DEVELOPED CAPSULES	PERCENTAGE OF DEVELOPED CAPSULES
1928		1928			
Feb. 14	10	Feb. 23	10	9	75.00
“ 14	12	“ 23	12	11	50.00
“ 22	22	March 1	19	16	94.11
“ 22	17	“ 1	16	11	100.00
“ 23	11	“ 11	11	15	100.00
March 11	15	‘ 20	15	14	100.00
“ 11	14	“ 20	14	9	90.00
“ 12	10	“ 20	9	16	88.88
“ 12	18	“ 22	16	17	100.00
“ 14	17	“ 22	17	15	75.00
“ 14	20	“ 22	15	11	68.75
“ 16	16	“ 26	16	10	66.66
“ 17	15	“ 28	14	8	88.88
“ 20	9	“ 28	9	8	88.88
“ 20	10	“ 28	10	8	80.00
“ 20	14	“ 28	13	11	75.57
“ 20	10	“ 28	10	10	100.00
“ 28	8	April 5	6	6	75.00
“ 28	12	“ 5	12	12	100.00
“ 28	11	“ 5	6	6	54.54
“ 28	10	“ 5	10	10	100.00
“ 28	6	“ 5	6	6	100.00
“ 28	8	“ 5	8	8	100.00
April 5	9	“ 12	8	8	77.77
“ 5	7	“ 12	7	7	100.00
“ 12	13	“ 17	13	13	100.00

Average—87.04

TABLE 18

Results of bagging unemasculated tobacco flowers with dried banana leaves

DATE OF BAGGING	NUMBER OF FLOWERS BAGGED	DATE OF REMOVAL OF BAGGING MATERIALS	NUMBER OF CAPSULES LEFT	NUMBER OF DEVELOPED CAPSULES	PERCENTAGE OF DEVELOPED CAPSULES
1928		1928			
Feb. 15	5	Feb. 23	5	4	80.00
" 22	12	March 1	10	10	83.33
" 22	17	" 1	17	17	100.00
March 14	9	" 22	9	9	100.00
" 14	15	" 22	10	10	66.66
" 14	11	" 22	8	8	72.72
" 15	15	" 26	15	15	100.00
" 20	17	" 28	17	17	100.00
" 22	13	April 1	13	11	84.63
" 22	10	" 1	10	10	100.00
" 22	7	" 1	7	7	100.00
" 26	15	" 5	14	14	93.33
" 28	20	" 5	20	20	100.00
April 1	14	" 8	10	10	71.42
" 1	16	" 8	16	16	100.00
" 1	9	" 8	8	8	88.88
" 5	13	" 12	9	5	30.76
" 5	10	" 12	10	10	100.00
" 5	7	" 12	7	7	100.00
" 12	5	" 17	5	5	100.00

Average—88.58

TABLE 19

Results of bagging unemasculated tobacco flowers with dried canna leaves

DATE OF BAGGING	NUMBER OF FLOWERS BAGGED	DATE OF REMOVAL OF BAGGING MATERIALS	NUMBER OF CAPSULES LEFT	NUMBER OF DEVELOPED CAPSULES	PERCENTAGE OF DEVELOPED CAPSULES
1928		1928			
Feb. 14	12	Feb. 23	11	11	91.66
" 14	15	" 23	15	15	100.00
" 18	19	March 1	19	19	100.00
March 1	6	" 11	3	1	16.66
" 14	13	" 22	13	13	100.00
" 14	10	" 22	10	10	100.00
" 14	12	" 24	11	8	66.66
" 16	15	" 26	15	13	86.66
" 16	10	" 26	10	6	60.00
" 20	12	" 28	12	12	100.00
" 20	12	" 28	12	12	100.00
" 20	15	" 28	10	6	40.00
" 22	13	April 1	13	13	100.00
" 22	14	" 1	14	14	100.00
" 22	18	" 1	18	18	100.00
" 24	11	" 1	11	11	100.00
" 28	12	" 5	9	9	75.00
" 28	13	" 5	13	13	100.00
" 28	11	" 5	11	11	100.00
" 28	6	" 5	6	6	100.00
April 8	9	" 16	7	7	77.77

Average 86.10

TABLE 20

Results of bagging unemasculated tobacco flowers with boho bamboo

DATE OF BAGGING	NUMBER OF FLOWERS BAGGED	DATE OF REMOVAL OF BAGGING MATERIALS	NUMBER OF CAPSULES LEFT	NUMBER OF DEVELOPED CAPSULES	PERCENTAGE OF DEVELOPED CAPSULES
1928		1928			
Feb. 18	11	Feb. 27	11	11	100.00
" 19	10	" 27	10	10	100.00
" 19	12	" 27	12	12	100.00
" 27	9	March 11	5	5	55.55
March 11	15	" 20	15	15	100.00
" 11	13	" 20	13	11	84.61
" 15	16	" 26	16	16	100.00
" 15	14	" 26	10	8	57.14
" 15	17	" 26	17	10	58.82
" 20	22	" 28	20	19	86.38
" 20	19	" 28	19	15	78.94
" 20	11	" 28	11	11	100.00
" 22	8	April 1	8	8	100.00
" 22	12	" 1	11	11	91.66
" 26	8	" 5	8	8	100.00
" 26	17	" 5	13	8	47.05
" 28	9	" 5	9	9	100.00
" 28	7	" 5	7	7	100.00
" 29	13	" 5	13	13	100.00
April 5	7	" 12	7	6	85.71
" 5	9	" 12	9	9	100.00

Average—87.89

TABLE 21

Results of bagging unemasculated tobacco flowers with dried tobacco leaves

DATE OF BAGGING	NUMBER OF FLOWERS BAGGED	DATE OF REMOVAL OF BAGGING MATERIALS	NUMBER OF CAPSULES LEFT	NUMBER OF DEVELOPED CAPSULES	PERCENTAGE OF DEVELOPED CAPSULES
1928		1928			
Feb. 22	19	March 1	13	13	68.42
" 22	16	" 1	15	15	93.75
March 1	12	" 11	6	6	50.00
" 1	13	" 11	8	8	61.53
" 14	15	" 22	12	12	80.00
" 14	11	" 22	11	9	81.81
" 14	11	" 22	6	6	54.54
" 20	15	" 28	15	10	66.66
" 20	19	" 28	19	9	47.36
" 20	10	" 28	10	10	100.00
" 28	13	April 5	13	10	76.92
" 28	15	" 5	14	14	93.38
" 29	14	" 5	12	12	85.71
April 5	17	" 12	17	17	100.00

Average—75.75

TABLE 22

Results of bagging unemasculated tobacco flowers with dried anahaw leaves

DATE OF BAGGING	NUMBER OF FLOWERS BAGGED	DATE OF REMOVAL OF BAGGING MATERIALS	NUMBER OF CAPSULES LEFT	NUMBER OF DEVELOPED CAPSULES	PERCENTAGE OF DEVELOPED CAPSULES
1928		1928			
Feb. 13	5	Feb. 23	5	5	100.00
" 13	8	" 23	8	8	100.00
" 13	12	" 22	7	7	58.33
" 15	16	" 23	15	7	43.75
" 18	18	March 1	18	15	83.33
" 22	16	" 1	13	6	37.50
March 1	10	" 11	10	10	83.33
" 11	11	" 20	9	9	81.81
" 14	13	" 22	13	8	61.53
" 14	15	" 22	15	14	93.33
" 15	20	" 24	17	17	85.00
" 15	12	" 26	11	10	83.33
" 15	15	" 28	15	15	100.00
" 19	19	" 28	19	19	100.00
" 20	6	" 28	6	6	100.00
" 22	7	April 1	7	7	100.00
" 24	12	" 1	12	12	100.00
" 28	6	" 5	6	6	100.00
" 28	14	" 5	14	14	100.00
" 28	12	" 5	12	12	100.00
" 28	8	" 5	8	8	100.00
April 1	11	" 8	11	11	100.00
" 1	5	" 8	4	4	80.00
" 6	8	" 12	5	5	62.50
" 6	16	" 12	14	14	87.50

Average—82.64

TABLE 23

Results of bagging unemasculated tobacco flowers with dried gabi leaves

DATE OF BAGGING	NUMBER OF FLOWERS BAGGED	DATE OF REMOVAL OF BAGGING MATERIALS	NUMBER OF CAPSULES LEFT	NUMBER OF DEVELOPED CAPSULES	PERCENTAGE OF DEVELOPED CAPSULES
1928		1928			
Feb. 20	10	Feb. 27	10	10	100.00
" 20	12	" 27	10	10	83.33
" 20	15	March 1	13	13	86.66
March 1	13	" 11	13	11	84.61
" 14	18	" 22	9	9	50.00
" 14	7	" 22	7	2	58.57
" 20	15	" 28	14	10	66.66
" 20	10	" 28	10	9	90.00
" 20	17	" 28	17	15	88.23
" 22	9	" 28	9	9	100.00
" 22	14	" 29	14	14	100.00
" 22	9	" 29	7	7	77.77
" 26	15	April 1	13	10	66.66
" 28	10	" 5	10	10	100.00
" 28	20	" 5	18	18	90.00
" 29	18	" 5	18	16	88.88
April 5	11	" 12	11	11	100.00

Average—82.43

TABLE 24

Results of bagging unemasculated tobacco flowers with dried edible canna leaves

DATE OF BAGGING	NUMBER OF FLOWERS BAGGED	DATE OF REMOVAL OF BAGGING MATERIALS	NUMBER OF CAPSULES LEFT	NUMBER OF DEVELOPED CAPSULES	PERCENTAGE OF DEVELOPED CAPSULES
1928		1928			
Feb. 14	10	Feb. 23	10	10	100.00
" 15	12	" 23	9	9	75 00
" 15	18	" 23	16	12	66.66
" 18	13	March 1	8	8	61.53
" 22	15	" 11	14	4	26.66
" 23	12	" 11	12	12	100.00
March 1	13	" 11	12	9	69.23
" 11	13	" 20	13	13	100.00
" 11	14	" 20	11	11	78.57
" 15	11	" 26	6	4	36.36
" 20	14	" 28	14	14	100.00
" 20	12	" 28	10	10	83.33
" 20	11	" 28	9	9	81.81
" 24	15	April 1	15	15	100.00
" 28	10	" 5	10	10	100.00
" 28	10	" 5	7	6	60.00
" 28	16	" 5	10	10	62.50
" 28	20	" 5	20	20	100.00
April 5	19	" 12	17	17	89.47
" 5	13	" 12	13	13	100.00
" 5	8	" 12	6	6	75.00

Average—79.33

TABLE 25

Results of bagging unemasculated tobacco flowers with ordinary bamboo joints

DATE OF BAGGING	NUMBER OF FLOWERS BAGGED	DATE OF REMOVAL OF BAGGING MATERIALS	NUMBER OF CAPSULES LEFT	NUMBER OF DEVELOPED CAPSULES	PERCENTAGE OF DEVELOPED CAPSULES
1928		1928			
Feb. 18	10	Feb. 27	10	10	100.00
" 19	12	" 27	12	12	100.00
" 19	19	March 11	11	11	57.89
March 12	11	" 20	9	8	72.72
" 12	16	" 20	14	14	87.50
" 14	22	" 22	20	20	90.90
" 14	19	" 22	15	10	52.63
" 15	10	" 28	10	10	100.00
" 17	9	" 28	9	9	100.00
" 20	11	" 28	8	6	54.54
" 20	12	" 28	12	10	83.33
" 22	9	" 28	9	9	100.00
" 22	12	" 28	12	12	100.00
" 28	16	April 5	16	16	100.00
" 28	15	" 5	12	12	80.00
" 28	7	" 5	2	2	28.57
" 28	14	" 5	10	8	57.14
April 5	9	" 12	2	1	11.11
" 5	13	" 13	13	13	100.00

Average—77.70

TABLE 26

Results of bagging unemasculated tobacco flowers with dried tibig leaves

DATE OF BAGGING		NUMBER OF FLOWERS BAGGED	DATE OF REMOVAL OF BAGGING MATERIALS		NUMBER OF CAPSULES LEFT	NUMBER OF DEVELOPED CAPSULES	PERCENTAGE OF DEVELOPED CAPSULES
1928			1928				
Feb.	15	8	Feb.	23	8	8	100.00
"	15	9	"	23	9	9	100.00
"	15	16	"	23	12	12	75.00
"	18	11	March	11	7	7	63.63
"	22	7	"	1	7	7	100.00
"	23	13	"	1	6	6	46.15
"	28	15	"	11	13	13	86.66
March	11	16	"	20	7	7	43.75
"	11	12	"	20	11	10	83.33
"	14	16	"	20	14	9	52.25
"	14	6	"	24	6	6	100.00
"	16	14	"	24	11	7	50.00
"	20	9	"	28	8	8	88.88
"	20	17	"	28	9	9	52.94
"	20	8	"	29	8	8	100.00
"	22	8	April	1	7	7	87.50
"	24	15	"	1	13	13	86.66
"	24	9	"	1	9	9	100.00
"	28	8	"	5	8	8	100.00
"	29	9	"	5	5	5	55.55
April	5	11	"	12	11	11	100.00
"	12	5	"	17	5	3	60.00

Average—78.92

TABLE 27

Results of bagging unemasculated tobacco flowers with dried lumbang leaves

DATE OF BAGGING	NUMBER OF FLOWERS BAGGED	DATE OF REMOVAL OF BAGGING MATERIALS	NUMBER OF CAPSULES LEFT	NUMBER OF DEVELOPED CAPSULES	PERCENTAGE OF DEVELOPED CAPSULES
1928		1928			
Feb. 18	16	Feb. 27	9	9	56.75
“ 18	9	March 1	9	9	100.00
“ 19	15	Feb. 27	15	13	86.66
“ 22	10	March 1	6	6	60.00
“ 22	22	“ 1	22	20	95.45
March 11	11	“ 20	4	4	36.36
“ 11	18	“ 20	15	15	83.33
“ 14	12	“ 22	12	12	100.00
“ 14	13	“ 22	13	10	76.92
“ 16	11	“ 24	7	4	36.36
“ 20	15	“ 28	14	13	86.66
“ 20	11	“ 28	10	10	90.90
“ 20	12	“ 29	12	12	100.00
“ 22	9	“ 29	6	6	66.66
“ 22	13	“ 29	10	10	76.92
“ 24	17	April 1	17	17	100.00
“ 26	14	“ 5	14	14	100.00
“ 28	9	“ 5	9	7	77.77
“ 29	9	“ 5	9	9	100.00
April 5	8	“ 12	4	4	50.00
“ 5	8	“ 12	8	6	75.00

Average—78.82

TABLE 28

Results of bagging unemasculated tobacco flowers with dried castor bean leaves

DATE OF BAGGING	NUMBER OF FLOWERS BAGGED	DATE OF REMOVAL OF BAGGING MATERIALS	NUMBER OF CAPSULES LEFT	NUMBER OF DEVELOPED CAPSULES	PERCENTAGE OF DEVELOPED CAPSULES
1928		1928			
Feb. 18	12	March 11	9	9	75.00
“ 19	12	“ 27	12	12	100.00
“ 19	13	“ 27	11	11	84.61
March 11	11	“ 20	5	3	27.27
“ 11	18	“ 20	16	16	88.88
“ 14	20	“ 22	14	14	70.00
“ 17	12	“ 24	12	6	50.00
“ 20	9	“ 28	7	7	77.77
“ 20	15	“ 14	14	14	93.33
“ 22	11	April 1	11	11	100.00
“ 24	8	“ 1	7	7	87.50
“ 28	12	“ 5	12	12	100.00
“ 28	14	“ 5	14	14	100.00
April 1	12	“ 8	6	5	81.81
“ 5	11	“ 12	11	9	78.52

Average—78.52

TABLE 29

Results of bagging unemasculated tobacco flowers with dried darumaka leaves

DATE OF BAGGING	NUMBER OF FLOWERS BAGGED	DATE OF REMOVAL OF BAGGING MATERIALS	NUMBER OF CAPSULES LEFT	NUMBER OF DEVELOPED CAPSULES	PERCENTAGE OF DEVELOPED CAPSULES
1928		1928			
Feb. 20	12	Feb. 27	12	11	91.66
March 12	14	March 20	13	11	78.57
" 12	8	" 20	7	7	87.50
" 12	13	" 20	6	6	46.15
" 14	18	" 22	18	18	100.00
" 14	12	" 22	9	9	75.00
" 20	18	" 26	17	14	77.77
" 20	11	" 28	6	6	54.54
" 20	11	" 28	9	7	63.63
" 22	15	" 29	14	14	93.33
" 22	14	" 29	14	14	100.00
" 28	15	April 5	15	15	100.00
" 28	16	" 5	16	12	75.00
" 28	13	" 5	11	11	84.61
April 5	16	" 12	16	16	100.00

Average—81.85

TABLE 30

Results of bagging unemasculated tobacco flowers with dried Macaranga tanarius leaves

DATE OF BAGGING	NUMBER OF FLOWERS BAGGED	DATE OF REMOVAL OF BAGGING MATERIALS	NUMBER OF CAPSULES LEFT	NUMBER OF DEVELOPED CAPSULES	PERCENTAGE OF DEVELOPED CAPSULES
1928		1928			
March 12	9	March 20	9	9	100.00
" 12	16	" 20	14	14	87.50
" 14	7	" 20	3	3	42.85
" 14	10	" 22	10	7	70.00
" 14	12	" 22	11	11	91.66
" 20	9	" 26	9	9	100.00
" 20	16	" 28	14	12	75.00
" 20	13	" 28	12	9	69.23
" 22	5	April 1	5	5	100.00
" 22	11	" 1	11	11	100.00
" 26	11	" 1	10	10	90.90
" 27	14	" 5	12	8	57.14
" 28	13	" 5	13	13	100.00
" 28	19	" 5	14	14	73.68
April 1	12	" 8	6	5	41.66
" 5	11	" 12	11	9	81.81

Average—80.08

TABLE 31

Summary of tables 3 to 30

NAME OF BAGGING MATERIALS	PERCENTAGE OF UNEMASCULATED PODS WHICH DID NOT DEVELOP	PERCENTAGE OF UNEMASCULATED PODS WHICH DEVELOPED
Banana sheath	100.00	87.04
Banana leaves	100.00	88.58
Bandera española leaves	100.00	86.10
Boho bamboo	99.59	87.89
Tobacco leaves	100.00	75.71
Anahaw leaves	100.00	85.64
Gabi leaves	100.00	82.43
Edible canna leaves	100.00	79.33
Bamboo joints	99.20	77.20
Ficus nota leaves	100.00	78.92
Lumbang leaves	99.11	78.82
Castor plant leaves	99.86	78.52
Darumaka leaves	99.54	81.85
Binonga leaves	100.00	80.08

TABLE 32

Results of leaving flowers unemasculated and unbagged

DATE OF MARKING	NUMBER OF FLOWERS	DATE EXAMINED	NUMBER OF CAPSULES LEFT	NUMBER OF DEVELOPED CAPSULES	PERCENTAGE OF DEVELOPED CAPSULES
1928		1928			
April 25	36	April 29	36	34	94.44
" 25	13	" 29	13	13	100.00
" 25	15	" 29	15	14	93.33
" 25	8	" 29	5	3	37.50
" 25	10	" 29	10	10	100.00
" 25	5	" 29	5	3	60.00
" 25	7	" 29	7	3	42.85
" 25	8	" 29	8	8	100.00
" 25	6	" 29	6	6	100.00
" 25	16	" 29	14	9	56.25
" 25	27	" 29	27	24	88.88
" 25	10	" 29	10	2	20.00
" 25	23	" 29	16	14	60.84
" 25	7	" 29	7	7	100.00
" 25	19	" 29	19	16	84.21
" 25	20	" 29	20	18	90.00
" 25	12	" 29	12	12	100.00
" 25	9	" 29	9	9	100.00
" 25	12	" 29	12	12	100.00

Average—80.43

TABLE 33

Results of laboratory germination tests of seeds from emasculated pods

BAGGING MATERIALS	DATE OF GERMINATION	NUMBER OF SEEDS USED	NUMBER OF SEEDS GERMINATED	DATE COUNTED	PERCENTAGE OF GERMINATION
	1928			1928	
Boho Bamboo	July 13	72	67	July 24	93.05
Bamboo joints	July 13	72	69	July 24	95.83
Castor plant leaves	July 13	72	56	July 24	77.50
Darumaka leaves	July 13	72	58	July 24	81.94
Lumbang leaves	July 13	72	42	July 24	58.47

TABLE 34

Results of laboratory germination tests of seeds from unemasculated pods

BAGGING MATERIALS	DATE OF GERMINATION	NUMBER OF SEEDS USED	NUMBER OF SEEDS GERMINATED	DATE COUNTED	PERCENTAGE OF GERMINATION
	1928			1928	
Banana sheaths	June 19	72	59	June 29	81.94
Banana leaves	June 18	72	68	June 26	94.44
Bandera española leaves	June 19	72	69	June 29	95.83
Boho bamboo	June 19	72	66	June 29	91.94
Tobacco leaves	June 18	72	72	June 26	100.00
Anahaw leaves	June 18	72	70	June 26	97.22
Gabi leaves	June 18	72	66	June 26	91.94
Edible canna leaves	June 18	72	69	June 29	95.83
Bamboo joints	June 19	72	67	June 29	93.05
Ficus nota leaves	June 19	72	45	June 29	62.50
Lumbang leaves	June 19	72	65	June 29	90.27
Binonga leaves	June 19	72	67	June 29	88.88
Darumaka leaves	June 18	72	67	June 26	93.05
Control[3]	June 19	72	58	June 26	80.55

[3] The seeds used for control were bagged with Manila paper bag.

NOTE: THE PRESENT CONDITION OF THE COLLEGE RURAL HIGH SCHOOL

The College Rural High School was opened on June 10, 1929, with a total enrollment of 190 in the first and second years. Due to limited accommodation several students were not allowed to enroll. The students who have enrolled are from twenty-three provinces. Selection of pupils was on the basis of previous application and physical examination, as well as upon credentials obtained from the schools last attended.

The school was established for the purpose of having a model rural high school for use in the training of vocational agricultural teachers who will afterward go out to teach in the rural and agricultural high schools under the Bureau of Education. This model rural high school is being conducted on the same basis as the regular rural high schools under the Bureau of Education, but with certain modifications in order to meet the needs of the students and the University entrance requirements, as well as the exigencies of the vocational teachers' training department of the College.

The farm contains approximately twenty-three hectares of land. About one-fourth of this area is already cleared and ready for planting. The whole farm site is rolling and has good soil which is suited to diversified farming. At present no irrigation system is available, but it is expected that during the present school year a gravity ditch will be constructed by the students.

As rapidly as land can be divided, boys are given plot assignments. Each pupil is required to plant at least 1,000 square meters of land with various important vegetables and secondary crops. Students in the second-year group are given more or less independent livestock projects on the school farm. They will conduct these projects as productive enterprises, the school furnishing the stock and other necessary equipment. Plans are under way to have the students build temporary cottages with the assistance of the Department of Animal Husbandry of the College.

There is no home economics course, but the girls who have enrolled in the first year are doing special work in horticulture. Their work consists of flower culture, landscape gardening and, to a limited extent, vegetable and fruit culture. Their field laboratory is conducted in the nursery of the Department of Agronomy of the College. This course for girls is only an experiment and it is hoped that eventually a home economics course may be offered.

Instruction is largely carried on by the teachers of the School as well as by some instructors detailed from various departments of the College. Most of the academic classes are held in the new twenty-one thousand peso agricultural building which is now almost completed. The overflow is being accommodated in different buildings of the College proper.

—Felipe O. Cevallos.

THE COLLEGE TRAPNEST[1]

F. M. FRONDA AND P. S. PAJE
Of the Department of Animal Husbandry

WITH THREE TEXT FIGURES

Poultry raisers like to know how many of their hens are profit earners and how many lay only enough eggs for their keep and are therefore boarders. Also from the standpoint of the improvement of the egg production of a flock, it is essential to know from which of the profitable layers eggs may be saved for hatching. To know these things, one must be able to keep track of the actual number of eggs laid by the hens, if not during the entire year, at least within a certain period. There is but one accepted accurate means of doing this and that is by using a trapnest. With the use of this device, one can easily pick out the non-profitable hens, which may be culled and sold for table use. By so doing, the feed expenses of the poultry raiser may be reduced, and at the same time, the chance of hatching eggs from these unprofitable hens may be minimized. This will tend to produce a rapid improvement in the egg production of the flock.

The trapnest is a nest provided with a device that allows a hen to get inside but prevents her from getting out after laying unless she is released by an attendant. A trapnest to be useful and practical must satisfy the following requirements: (1) It should be efficient, that is, not more than one hen at a time can get inside, and once inside, the hen cannot go out until released. (2) It should be roomy and comfortable, dimly lighted and well ventilated. (3) It should be easy to clean. (4) It should be economical and easy to make.

During the last three years, a trapnest adapted from one of those recommended by Dougherty and Gossman of the California Station[2] has been in use in this College. Models of this trapnest have been asked for by those who have seen it in operation. Numerous requests for copies of plans of this nest and for directions for making it have been received. It is hoped that this paper will satisfy these demands for information regarding this particular device which we have named the "College trapnest."

THE COLLEGE TRAPNEST

The materials needed to make a complete College trapnest are a kerosene box with cover, three No. 111 screw eyes, and two screw hooks of the

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[1] Experiment Station contribution No. 608. Received for publication December 12, 1928.

[2] Dougherty, J. E., and S. S. Gossman. 1923. Inexpensive labor-saving poultry appliances. California Experiment Station Circular 268: 1–32. Fig. 1–24.

same size, a piece of No. 6 wire 25 cm. long, and a few nails. If removed carefully, no extra nails will be necessary as those taken from the box will be sufficient. The tools necessary in making the nest are a saw and a hammer. If available, a pair of pliers will be found handy.

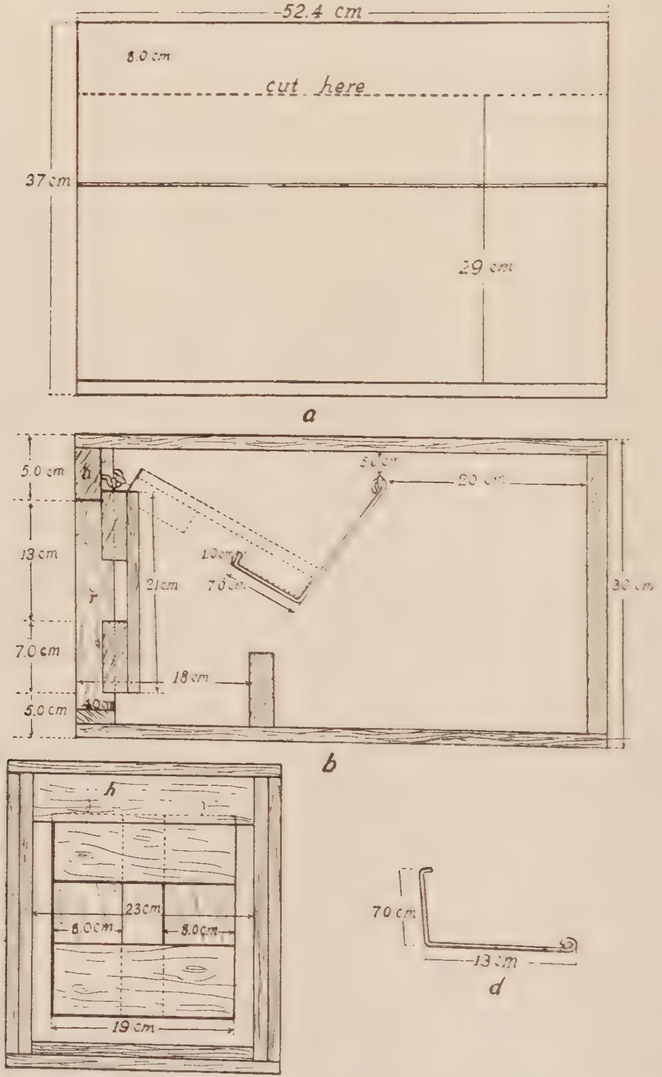

Fig. 1.—Details of the College trapnest. (*a*) Side view of a kerosene box, cover removed, showing where to cut (dotted line) lengthwise. (*b*) A trapnest in section, showing essential parts. (*c*) Front view of nest showing door closed. (*d*) Hook.

How the nest is made. The exact dimensions of the common kind of kerosene box are given in figure 1. Both sides of the box are cut at the dotted line indicated which is 29 cm. from the bottom (outside measurement). One of the ends is also cut, and the other is carefully detached, saving all the nails removed therefrom. If the box has been cut in the right place, two long narrow strips about 8 cm. wide and 52.4 cm. long, the length of the kerosene box, will be cut from the sides. A strip, also 8 cm. wide will be taken from the end that has been cut. One of the long narrow strips is cut lengthwise into two equal parts making two strips that are about 4 cm. wide. From the strip removed from the other side, two pieces 21 cm. long are cut. From the end that has been removed without cutting, a strip 5 cm. wide and two pieces each 7 cm. wide are sawed off horizontally. The 5 cm. piece is cut 23 cm. long, and the 7 cm. strip 19 cm. long.

The end of the box from which the cover has been removed makes the door of the nest. This is reinforced on the sides and bottom with the 4 cm. strips. These reinforcemnts are indicated by *r* in *b* figure 1. Instead of using a piece of this width for reinforcing the top of the nest, the 5 cm. strip cut from the end is used. Because of the thickness of this piece, it serves also as the place from which the trap door is hung, so is called the *hanger*,—indicated by *h* in *b* and *c*, figure 1. The piece about 8 cm. wide taken from the sawed end, is nailed on the floor 18 cm. from the door of the nest. This piece serves as a *hurdle*, and its proper location (see *b* fig. 1) helps considerably in the efficiency of the trapnest. If, when nailing the reinforcements, the nails come through because of their length, they should be bent and hammered down. If this is not done the sharp ends may hurt the hen and the attendant.

The details of the construction of the door cover are shown in *c* figure 1. The two 8×21 cm. pieces cut from one of the sides are nailed to the two 7×19 cm. strips as indicated in figure. The door, if the pieces have been cut properly is about 19×21 cm. in size, leaving a space in the center about 5×7.5 cm. This opening, together with the spaces around the trap door, provides for sufficient ventilation.

Two screw eyes are fitted into the hanger at a convenient distance from each other and the trap door is hung from these by screwing the screw hooks at the same distance on the trap door. The place on the hanger where the eyes are screwed in is approximately two cm. from the lower edge. When the door is hooked on these, the upper end overlaps the lower edge of the hanger about one cm. This overlapping will serve as a check on the trap door when swinging forward, thus forming an automatic means of preventing the hen from getting out.

The third screw eye is fixed into one of the sides of the nest 5 cm. from the top and about 20 cm. from the end (inside dimensions). The wire hook is adjusted into this in such a way that the hook can swing freely both forward and backward (see *b* fig. 1). The details of the hoo shown in *d* fig. 1. The arm should be exactly 13 cm. long in order to get the proper door opening when the trap door is set. The hook should fit the lower beam of the frame of the trap door and it is essential that this hook must work quickly in releasing the trap door when it is raised by a hen entering the nest.

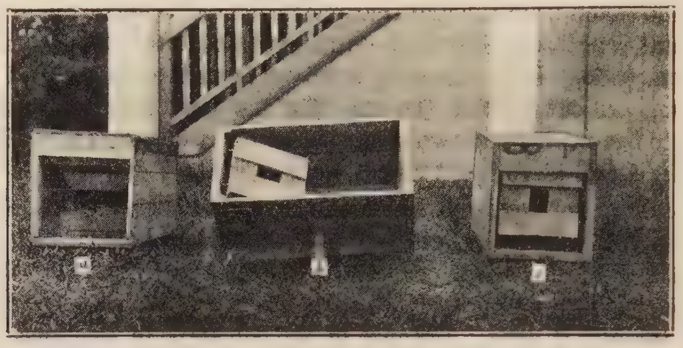

Fig. 2.—Different views of the College trapnest. (*a*) Showing the door open. (*b*) The top cover removed to show how door is held by hook. (*c*) Showing door closed.

How the nest operates. The nest is set by lifting the trap door with the hook as indicated in *a* figure 2. In *b* figure 2, the top cover of the nest has been removed to show the position of the trap door when seen at an angle from the top. If the hook has been properly made and hung in the proper place as indicated in *b* figure 1, the opening of the trapnest should be just right for hens of average size. On going into the nest, the hen raises her body slightly when she steps over the hurdle. When her body is raised, her back touches the trap door, raises it only slightly but enough to release the hook. The door then slides on the back of the hen and closes the nest quietly behind her. A closed nest is shown in *c* figure 2.

To release the hen, the door is swung inward and the hen is caught by attendant as she goes out. The hen's identification number is recorded on the large end of the egg she laid, together with the date of laying. The door is hooked as before and the nest is ready for another hen.

Cost of the nest. The nest is not only simple, and easy to make, but the cost of the materials and the cost of making it are comparatively low. Neither expensive materials nor the services of an expert carpenter are necessary. The common kerosene box costs only from 15 to 20 centavos.

The nest can be made in an hour, or less. Adding the cost of labor at 12 centavos an hour, and the cost of the hooks and eyes and wire which would be about 6 centavos, makes the nest cost about 38 centavos. So a poultry keeper with a little trouble can add to his equipment a device that will soon pay for itself many times over.

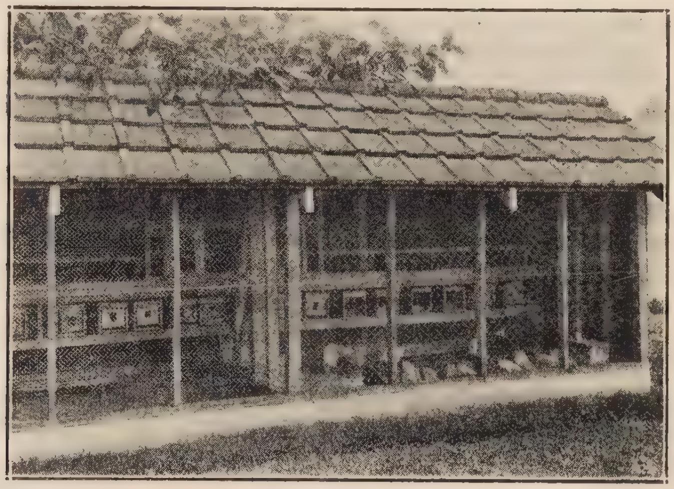

Fig. 3.—College trapnests in use.

Trapnest in a poultry house. There should be one trapnest for every three or four hens. Before placing the nests in the house, they are provided with proper nesting materials. The materials for this purpose should be, if possible, those that will not attract but will repel mites and other chicken parasites. The nest may be placed in any convenient place inside the poultry house, but a platform should be provided so that a hen may alight on it before entering the nest. If the poultry house is provided with a droppings board, these nests may be conveniently placed underneath this, as shown in figure 3. Or the nest may be placed on a platform fastened on the back and side walls of the house. In all cases, the nest must be located in places convenient both for the hens and for the attendant. Such places must also be within easy reach for thorough disinfection and cleaning.

Our experience in the use of the college trapnest during the last three years shows that not more than two per cent of all the eggs collected in the pens provided with these nests were unidentified. The nest is well ventilated, and there is not the slightest danger of a hen suffocating inside. Provided with sufficient nesting materials, no egg need be damaged. The slightly darkened condition of the interior of the nest prevents the hen from eating the contents of an egg should one become accidentally broken, thus the undesirable habit of egg eating is not acquired.

COLLEGE AND ALUMNI NOTES

The teaching personnel of the College of Agriculture has been materially increased by the appointment of the following new members at the beginning or shortly before the present academic year: Mrs. Helen A. Foster, A.B., '17, Des Moines University, assistant professor of agricultural education; Edwin E. Schneider, B.L., '97, Cincinnati, assistant professor of modern languages; Alejandro Catambay, M.S.A., '27, California, instructor in agronomy; Ramon A. Cruz, B.S.A., '24, U.P., instructor in chemistry; Paulino E. Costa, B.S., '23, California, instructor in horticulture and science (Agricultural Education); Miss Sue Denny, A.B., '19, Texas, instructor in English; Miss Hazel D. Reed, A.B., Morningside College, instructor in English (College Rural High School); Alejandro Ferrer, B.S.C.E., U.P., '25, instructor in mathematics; Eliseo K. Ongsangsoy, B.S.C.E., U.P., '26, instructor in agricultural engineering; Martin Celino, B.S.A., '29, U.P., assistant in plant pathology; Andres M. Mane, B. Agr., '29, U.P., assistant in agricultural zoölogy; Arcadio G. Matela, B. Agr., '29, U.P., assistant in agronomy; Arsenio Y. Coronel, B. Agr., '29, U.P., assistant in entomology; Albino P. Varona, B.S.A., '29, U.P., assistant in agronomy; Marcelo V. Arnaldo, B.S.A., '27, U.P., assistant in economics; Juan D. Atienza, B. Agr., '29, assistant in plant pathology; Atanacio Hizon, B.S.S.T., '28, assistant in chemistry; Honorato Lumang, B. Agr., '29, assistant in chemistry; Nazario Pidlaoan, B. Agr., '29, assistant in chemistry; Juan R. Pronto, B.S.A., '26, assistant in chemistry; Isabelo Sonza, B. Agr., '29, assistant in agricultural engineering; and Lauro Ynalvez, B. Agr., '29, assistant in chemistry.

Recent promotions in the faculty of the College: *From associate professors to professors*—Miss Emma S. Yule (English); Dr. R. B. Espino (plant physiology); Dr. N. B. Mendiola (agronomy); and Dr. L. B. Uichanco (entomology). *From instructors to assistant professors*—Misses Caroline Virginia Lee and Esther Anderson (English); Dr. Leon G. Gonzalez (agronomy); Dr. D. V. Villadolid (agricultural zoölogy); and Dr. Alexander Gordon (agricultural engineering). *From assistants to instruztors*—Mr. Silverio M. Cendaña (entomology) and Mr. Antonio L. Rocafort (physics).

The following papers were read in the forty-fifth scientific meeting of the Los Baños Biological Club on July 25, 1929:

1. The cost of producing pork at the College of Agriculture. Dr. Mariano Mondoñedo.

2. The effects of different types of fishing gears on kanduli (*Arius* spp.) fisheries of Laguna de Bay. Dr. Deogracias V. Villadolid.

Dr. Valente Villegas, assistant professor of animal husbandry, has been designated assistant head of the Department of Animal Husbandry effective July 1, 1929.

Among the foreign scientists who visited the College in July were Dr. O. K. Shiratori, Meteorological Institute, Taihoku Imperial University, Formosa; Phra Bhojakara, Ministry of Agriculture, Bangkok, Siam; Dr. Oswald Schreiner, Dr. Robert D. Rands, and Mr. H. T. Edwards, of the U. S. Department of Agriculture; and Dr. Kintaro Oshima, of Taihoku Imperial University and Government Research Institute, Formosa.

Mr. Alejandro Catambay, instructor in agronomy, celebrated July 4 by getting married in Tanay, Rizal, to Miss Adela Medinaceli. Mrs. Catambay was a former student of the College of Medicine of the University.

First Lieutenant J. E. Olivares (P.S.), formerly of Fort Mills, Corregidor, has relieved First Lieutenant Amado Martelino as assistant commandant of the Los Baños unit of the University corps of cadets. This unit, by the way, has been baptized this year as "First Battalion, Second Regiment, University Corps of Cadets." The battalion commander is temporary Cadet Major Salvador Oliveros. The companies consist of Companies A, B, and C, and are commanded respectively by temporary Cadet Captains Francisco Gestoso, Pio Oabel, and Wenceslao Tiongson.

The First Battalion starts the present academic year with a record enrollment of 532 cadets.

The cadets elected Miss Soledad Marfori as their battalion sponsor; Miss Anita San Valentin, "A" company; Miss Apolonia Eusebio, "B" company, and Miss Lucia Cleto, "C" company.

OBSERVATIONS ON THE TIME OF HEALING BY THE SLIT AND CAP METHODS OF CASTRATION[1]

VICENTE D. GAVIOLA

INTRODUCTION

As a general thing, preference for one method of castration over another rests on the length of time required for healing. The advantages of the shorter healing time are: (a) the danger of complications from infection is lessened because of shorter time of exposure; (b) the pain and hardships of the animal operated upon, and the medical treatment and confinement are lessened; (c) and with work bullocks a saving in time is effected. If there is a gain in time in healing by any method a knowledge of it would be of practical importance to live stock owners.

Object of work

The object of this work was to find out the effect on the time of healing of castration by the slit and by the cap methods.

Time and place

The work was conducted in the Department of Animal Husbandry, College of Agriculture, and in the neighboring barrios of the municipality of Los Baños, Laguna. The work was begun on July 13, 1927, and closed on February 13, 1929, covering a period of 19 months.

MATERIALS AND METHODS

Animals

Altogether four horses, six carabaos, eighteen oxen, three sheep, and seven goats were subjected to the operation of castration during the period of this experiment. A detailed description of the animals as to breeding and age may be seen in table 1.

Equipment

Casting harness for the different kinds was used in throwing down horses, water buffaloes, and cattle. Additional ropes were employed in tying the legs together preparatory to the castration operation.

In performing the actual operation of castration the most important instrument used was an emasculator, provided with double crushing sur-

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[1] Thesis presented for graduation, 1929, from the College of Agriculture with the degree of Bachelor of Agriculture No. 297; Experiment Station contribution No. 617. Prepared in the Department of Animal Husbandry under the direction of Assistant Profesor Valente Villegas.

THE PHILIPPINE AGRICULTURIST, VOL. XVIII, NO. 4, SEPTEMBER, 1929.

faces. A sharp jack knife was also used. A clean rag dipped in disinfectant to clean the area of operation and the wound completed the equipment.

Medicinal preparations

Three per cent creoline solution and tincture of iodine were used to disinfect the instruments and the scrotum. A mixture of equal parts of cosmoline and pine tar with a few drops of creoline was applied to the wound after the operation as a fly repellant and also as a disinfectant.

Procedure

Two methods of castration were employed: namely, the slit and the cap methods.

With horses only the slit method was used, the cut being made below each half of the scrotum, parallel to the median raphe.

With water buffaloes and cattle both methods were used. In the slit method the slit was made at the apex of the scrotum across the raphe, thus making only one cut to cover both halves of the scrotum. With sheep and goats only the cap method was used.

Preparatory to castration, which was generally early in the morning, each animal was subjected to the following treatment: it was fasted for about 18 hours and given neither feed nor water. The large animals were cast and hogtied. When the animal was securely roped, a man held down its head and another held the ropes tied around the legs away from the operator, then the animal was ready for the operation. The scrotum, if dry and clean, was painted with tincture of iodine, and, if soiled, was washed with creoline solution. With a sharp knife a cut was made through the scrotum and tunica vaginalis into the testes. With the slit method, before cutting the scrotum, the testes were pressed downward so that upon cutting through the scrotum very little effort was necessary to reach the testes. With the cap method, the tip of the scrotum having been removed, the knife was stuck through the tunica vaginalis to the testes, thereby exposing them. If the operation is performed rapidly there is hardly any need to wash off excess blood before the emasculator is applied to crush the spermatic cord. The next step is to cut the tunica vaginalis with the knife at the point where it connects with the mesorchium, freeing the spermatic cord in this way from connective tissue that might obstruct when the emasculator is applied. Each testis is then pulled out gradually, the mesorchium meanwhile being pushed inward, and the emasculator is applied on the exposed spermatic cord, care being taken that the cutting blade of the instrument is towards the outside and the crushing parts towards the body of the animal. The spermatic cord should be cut in young animals as near the body as possible without excessive pulling lest it be torn off before the emasculator is applied. With older animals the emasculator is pressed on the spermatic cord for about two minutes to crush it. After the emasculator has been removed the blood is carefully wiped out with a piece of cloth and the fly repellant is then painted lightly over the wound as well as over the surrounding parts of the scrotum. The animal is then freed and made to stand, and tied to a tree in the shade for about two hours during which time no feed is given to him. This enforced quiet is to prevent the animal from indulging in excessive movements which might result in great flow of blood.

The animal is kept under observation as to duration of bleeding, swelling and the date when the wound is healed. Any pus formation is observed and recorded. Pine tar-cosmoline mixture is applied on the wound frequently, to prevent the flies from alighting on the wound, and laying eggs or infecting it. Whether it was raining or not the animals were kept in the pasture, tying them under trees for shelter if it was stormy. In other words the management was about the same as field conditions under which farm animals are generally kept instead of such treatment as animals receive as clinical patients in a veterinary hospital.

The animal was pronounced healed as soon as the wound of the scrotum was closed and dry and free from infection.

With young lambs and kids the operation consisted in the capping of the apex of the scrotum, then removing both testes with the teeth of the operator. No disinfectant was applied before or after the operation and any bleeding that followed was stopped only by the coagulation of the blood. The length or diameter of the cut on the scrotum depended largely on the size of the testis.

DISCUSSION OF RESULTS

By the duration of bleeding as used in this paper is meant the length of time the wound bleeds after the animal stands. Observation on swelling refers only to marked swelling and does not include slight congestion discernible only by close examination. Pus formation refers to the presence of white matter in the wound.

The duration of bleeding, duration of swelling, formation of pus, time of healing under the slit and cap methods of castration

Horses. As may be seen in table 2, with two of the younger horses there was no bleeding after the operation. One bled for 10 minutes after castration, while the oldest animal bled for 13 minutes and intermittently 12 hours after the operation.

The duration of swelling with horses averaged 5.3 days, the shortest duration being 3 days and the longest 10 days.

The average time till pus was first observed was 6.3 days from the date of operation, the range being from 4 to 13 days.

The healing of the wound on the scrotum with horses took on an average 17.3 days. The shortest period was 11 days and the longest 21 days.

Water buffaloes. Table 3 shows that with water buffaloes castrated by the cap method the average duration of bleeding was 30 minutes, the youngest animal bleeding for 50 minutes, and the two older animals for 20 minutes each. With animals castrated by the slit method, the average duration of bleeding was 38.3 minutes. In one of the animals the blood coagulated immediately after the operation; in one animal the bleeding lasted for 80 minutes.

The average duration of swelling with water buffaloes castrated by the cap method was 2.7 days. Animals operated upon by the slit method gave an average swelling period of 4 days.

With water buffaloes that were castrated by the slit method pus formation was observed at an average of 5.3 days from the date of operation. The youngest of these animals did not show any pus formation. One animal was observed to have pus on the tenth day after castration. No animal that was capped showed any infection or pus.

The healing time of water buffaloes castrated by the cap method was on an average 9 days, the shortest time being 8 days with the youngest animal and the longest period 10 days with an older one. With animals operated upon by the slit method the average healing time was 11.7 days, the range being from 7 to 18 days. Considering the small number of animals under observation and the little difference in length of the healing time of animals castrated by the cap method and slit method, it may be said that it was practically the same.

Cattle. As may be seen in table 4, the average duration of bleeding with cattle castrated by the cap method was 18.9 days, two of the animals showed no hemorrhage after the operation; the longest period of bleeding was 40 minutes. With cattle castrated by the slit method, the average duration was 46.9 minutes, one animal in this group showed no bleeding, and one bled for three hours. In both groups the duration of bleeding was observed to be less in younger animals. With cattle castrated by the cap method, the average duration of swelling was 7 days. With animals castrated by the slit method there was swelling for 5.8 days. With animals that were capped the swelling lasted a shorter time with younger animals, while under the slit method of castration the swelling was about the same whether the animal was young or old.

Pus formation was observed on an average of 8.1 days after the operation with animals castrated by the cap method. Under the slit method, the average was 6.4 days. Under both methods of castration the absence of infection was observed in young animals.

The healing time with cattle that were capped averaged 15.2 days from the time of castration, the minimum being 7 days and the maximum 24 days. With animals operated upon by the slit method the average healing time was 17.6 days, the shortest period being 8 days and the longest, 24. The little difference in favor of the cap method may be taken as insignificant, so that under both methods of castration the healing time with cattle is approximately the same, a little over two weeks.

Sheep. Table 5 shows that with young lambs of an average age of 3.7 days, the healing time in each case from the date of castration was 2 days. In none did bleeding and swelling take place, and the wounds were apparently free from infection as evidenced by their freedom from pus, although no disinfectant was used before or after the operation. Though only three sheep were used, the results were so uniform that they may be taken as strongly indicative of the true result.

Goats. Table 6 shows the same results as were obtained with sheep in that with all the goats castrated by the cap method the healing time was 2 days. There was neither bleeding, nor swelling observed after the operation. Neither was pus observed, indicating that the wounds were free from infection. No disinfectant was used before or after the operation.

Healing time at different ages

Water buffaloes. According to table 7, the average healing time with two two-year-old water buffaloes was 7.5 days. With five-year-olds the average was 11.8 days, a difference of 4.3 days longer with these animals than with the two-year-olds.

Cattle. In table 8 it may be seen that the average healing time of the one-year-old cattle was 8 days. The two-year-olds averaged 13.5 days, or 5.5 days longer than the one-year-olds. With three-year-olds the average healing time was 19 days, or 11 days longer than that of the one-year-olds and 5.5 days longer than that of the two-year-olds. The average healing time for the mature animals was 19.9 days. It will be noted that the healing time of the mature animals is not materially different from that of the three-year-olds.

Comparative healing time of horses, water buffaloes, cattle, sheep and goats

Lambs and kids a few days old show the shortest average healing time, two days. These were castrated by the cap method. Next to these the two-year-old water buffaloes showed an average healing time of 7.5 days. This was about the same healing time as the one-year-old cattle which was 8 days on an average. The five-year-old water buffaloes gave an average healing time of 11.8 days which was 8 days shorter than the average, for mature oxen. Horses gave an average healing time of 17.3 days. The maximum healing period observed was for mature cattle which averaged 19.9 days. Carabaos healed faster than oxen of the same age.

SUMMARY OF CONCLUSIONS

1. With water buffaloes and cattle, the difference in healing time between the slit and cap method was insignificant but in favor of the cap method.

2. With mature animals the comparative average healing time was as follows: water buffaloes, 11.8 days; horses, 17.3 days; cattle, 19.9 days.

3. Young animals showed an average shorter healing time than older ones. The duration of bleeding and swelling of the scrotum after the operation was also generally less with the younger animals.

4. Sheep and goats a few days old gave an average healing time of two days.

5. Likewise, young animals showed more freedom from infection or pus than older individuals.

6. Carabaos healed faster than oxen.

TABLE 1

Breeding, age, length or diameter[a] *of wound of different classes of animals castrated*

ANIMAL NO.	BREEDING	AGE	LENGTH OR DIAMETER OF WOUND
		years	*cm.*
Horses			
Slit method:			
1	Native.	3	6
2	Native.	4	8
3	Native.	4	7
4	Native.	7	8
	Average.	4.5	7.3
Water buffaloes			
Slit method:			
1	Indian grade.	2	7
2	Native.	5	7.5
3	Native.	5	10
	Average.	4	8.2
Cap method:			
1	Indian grade.	2	6
2	Native.	5	6.5
3	Native.	5	7
	Average.	4	6.5
Cattle			
Slit method:			
1	Native.	1	5
2	Nellore grade. . . .	2	8
3	Native.	3	6
4	Nellore grade. . . .	3	10
5	Native.	4	8
6	Hereford grade. . .	5	11.5
7	Native.	6	12
8	Native.	6	7.5
9	Nellore grade. . . .	6	9
	Average	4	8.6
Cap method:			
1	Nellore grade. . . .	1	3.5
2	Hereford grade. . .	1	4.8
3	Nellore grade. . . .	1	4.5
4	Nellore grade. . . .	2	6
5	Native.	3	6
6	Native.	5	4
7	Nellore grade. . . .	5	9
8	Native.	6	8
9	Nellore grade. . . .	6	6
	Average.	3.3	5.8
Sheep		*days*	
Cap method:			
1	Indian grade.	2	2.5
2	Indian grade.	3	2
3	Indian grade.	6	1.8
	Average.	3.7	2.1
Goats			
Cap method:			
1	Nubian grade. . . .	7	1.5
2	Nubian grade. . . .	7	1.8
3	Nubian grade. . . .	10	1.5
4	Nubian grade. . . .	10	2
5	Nubian grade. . . .	13	2.3
6	Nubian grade. . . .	13	1.8
7	Nubian grade. . . .	15	2
	Average.	10.7	1.8

[a] Length of wound measured with animals castrated by the slit method, and diameter of wound taken with animals castrated by the cap method.

TABLE 2

Duration of bleeding, duration of swelling, pus formation, and healing time, by the slit method, of native horses

ANIMAL NO.	DURATION OF BLEEDING	DURATION OF SWELLING	TIME PUS OBSERVED	HEALING TIME
		days	*days*	*days*
1	0	10	5	16
2	0	3	4	11
3	10 min.	4	13	21
4	13 min. and intermittently 12 hours	4	5	21
	Average........	5.3	6.3	17.3

TABLE 3

Duration of bleeding, duration of swelling, pus formation and healing time of water buffaloes

ANIMAL NO.	CAP METHOD				ANIMAL NO.	SLIT METHOD			
	Duration of bleeding	Duration of swelling	Time pus observed	Healing time		Duration of bleeding	Duration of swelling	Time pus observed	Healing time
	min.	*days*	*days*	*days*		*min.*	*days*	*days*	*days*
1	50	3	0	8	1	35	3	0	7
2	20	0	0	9	2	0	4	6	10
3	20	5	0	10	3	80	5	10	18
Average	30	2.6	0	9	Average	38.3	4	5.3	11.7

TABLE 4

Duration of bleeding, duration of swelling, pus formation and healing time, by slit and cap methods with cattle

ANIMAL NO.	CAP METHOD				ANIMAL NO.	SLIT METHOD			
	Duration of bleeding	Duration of swelling	Time pus observed	Healing time		Duration of bleeding	Duration of swelling	Time pus observed	Healing time
	min.	*days*	*days*	*days*		*min.*	*days*	*days*	*days*
1	0	5	0	9	1	0	5	0	8
2	5	3	0	7	2	15	7	6	13
3	0	5	0	8	3	30	6	4	17
4	40	6	0	14	4	15	8	5	22
5	20	5	15	18	5	25	7	0	15
6	40	7	9	14	6	95	6	10	23
7	35	12	20	24	7	—	—	8	24
8	20	7	12	20	8	15	3	6	12
9	10	13	17	23	9	180	4	19	24
Average	18.9	7	8.1	15.2	Average	46.9	5.8	6.4	17.6

TABLE 5

Duration of bleeding, duration of swelling, time pus observed and healing time, by the cap method with sheep

ANIMAL NO.	DURATION OF BLEEDING	DURATION OF SWELLING	TIME PUS OBSERVED	HEALING TIME
		days	*days*	*days*
1	0	0	0	2
2	0	0	0	2
3	0	0	0	2
Average.	0	0	0	2

TABLE 6

Duration of bleeding, duration of swelling, time pus observed and healing time, by the cap method with goats

ANIMAL NO.	DURATION OF BLEEDING	DURATION OF SWELLING	TIME PUS OBSERVED	HEALING TIME
				days
1	0	0	0	2
2	0	0	0	2
3	0	0	0	2
4	0	0	0	2
5	0	0	0	2
6	0	0	0	2
7	0	0	0	2
Average.	0	0	0	2

TABLE 7

Healing time with two-year-old and five-year-old water buffaloes

TWO-YEAR-OLD		FIVE-YEAR-OLD	
Animal No.	Healing time	Animal No.	Healing time
	days		*days*
1s*...........	7	2s	10
1c*...........	8	3s	18
		2c	9
		3c	10
Average........	7.5		11.8

* *s* stands for slit and *c* for cap.

TABLE 8

Healing time of cattle at different ages

ONE-YEAR-OLD		TWO-YEAR-OLD		THREE-YEAR-OLD		MATURE ANIMALS	
Animal No.	Healing time	Animal No.	Healing time	Animal No.	Healing time	Animal No.	Healing time
	days		*days*		*days*		*days*
1s*	8	2s	13	3s	17	5s	15
1c*	9	4c	14	4s	22	6s	23
2c	7			5c	18	7s	24
3c	8					8s	12
						9s	24
						6c	14
						7c	24
						8c	20
						9c	23
Average.	8		13.5		19		19.9

* *s* stands for slit and *c* for cap.

SURVEYING FOR AREA WITH A SURVEYOR'S STAFF[1]

ALEXANDER GORDON
Of the Department of Agricultural Engineering

WITH EIGHT TEXT FIGURES

The surveyor's staff is one of the first instruments that surveyors ever used. A surveyor, with some degree of care, may use the staff with fairly good results. The simplicity of its construction, its handiness, and the lack of parts that would get out of adjustment make it an indispensable thing on the farm where there is much laying out to be done.

CONSTRUCTION

The construction of the surveyor's staff is very simple. A block of wood is set on a staff and lines at right angles to each other drawn on its surface. This would be the simplest type of staff.

The writer has devised a surveyor's staff that is no harder to construct than the simpler ones. A round block, two inches thick, was made. The block was sawed across the center to about half an inch in depth, then resawed across the center at right angles to the first cut. These cuts serve as sight lines.

The block is set on a staff by means of a peg so that the block may turn about its center. (See figure 1.) This method, the writer believes, is the best, as the block may be turned without turning the staff.

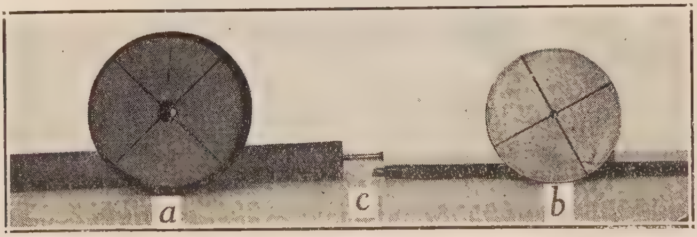

Fig. 1.—The surveyor's staff taken apart. *a*, wood block, *b*, iron block; *c*, wood and iron staffs showing pegs for block attachment. Note the saw cuts on the blocks

Wood is the material which the writer considers best adapted to farm use, for it is easily obtained on the farm.

Iron was tried, but it is not advisable, because it is hard to saw or notch.

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[1] Read at the meeting of the Agricultural Engineering Colloquium, March 5, 1929.

HOW TO USE A SURVEYOR'S STAFF

Set-up

The surveyor's staff is divided into two parts, the block and the staff. In setting up, the staff portion is first stuck in the ground at the point desired. Then the block is set on the staff. (See figure 2.) It is important that the staff be vertical. This may be accomplished with the help of a plumb bob.

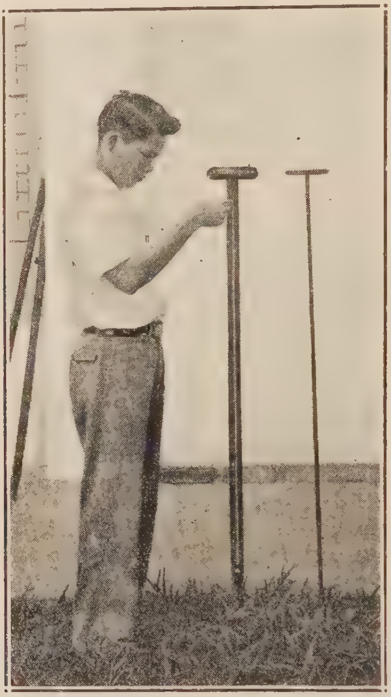

Fig. 2.—Setting the surveyor's staff vertical by means of a plumb bob

Erecting perpendiculars

To erect perpendiculars with the staff is not a complicated job. The first thing to do is to set the staff on the course at any desired point, say *O*. When stations *A* and *B* are easily accessible, locate *O* by sighting from either one of the stations towards the other and keep *O* in line. When *A* and *B* are inaccessible, however, locate *O* by one of the following methods:

First method. Set two rods, *a* and *b*, at some distance apart, between *A* and *B*. (See figure 3.) Sight *A* from *a* and bring *b* in line. Then sight *B* from *b* and bring *a* in line. Continue the process until *A*, *b*, *a*, and *B* are all in line. Now set the staff on the course *AB*.

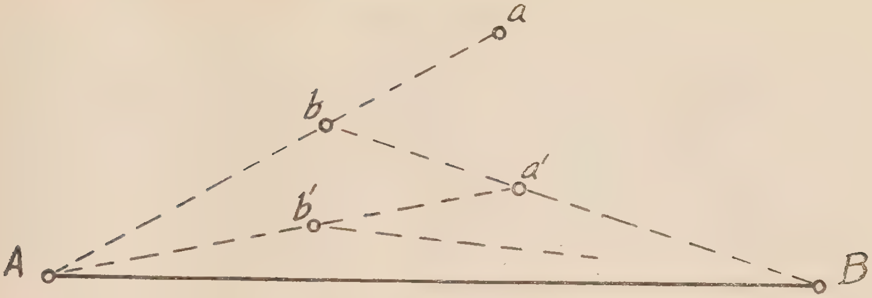

Fig. 3.—Locating an accessible point between two inaccessible points

Second method. Set the staff as nearly as possible on the course AB, at O'. (See figure 4.) From O' sight B through one of the slits, then sight back through the slit. If, on sighting back through the slit, A is not seen, transfer position of staff, say to O''. From O'' sight B through one of the slits, then sight back through the slit. If, on sighting back through the slit, A is not seen, transfer position of staff and continue the process until O' is in line with A and B.

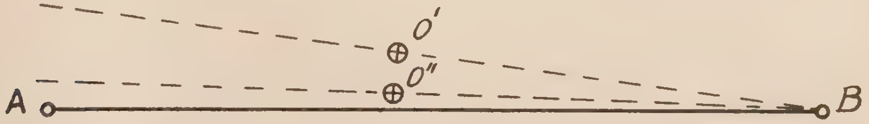

Fig. 4.—Locating a point between two points by the use of the surveyor's staff

Suppose now, that the staff is set at a point O, on the course AB. (See figure 5.) Sight B through the slit m-m of the block. Then sight to a point C through slit n-n (figure 5a). Turn the block so that B is sighted through slit n-n. Then sight through m-m to a point D (figure 5b). The line bisecting angle COD is perpendicular to line AB.

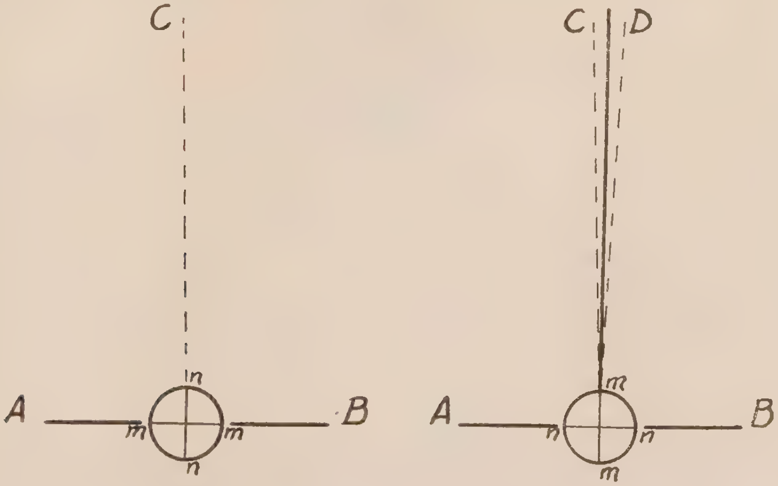

Fig. 5.—Erecting a perpendicular

Finding areas

Of a triangle. The area of a triangle may be found by multiplying one half of the base by its altitude. The measurement of the altitude is the problem. Suppose we have a triangle ABC. Then guess approximately point O on AB so that CO is almost perpendicular to AB. (See figure 6.) Set the staff on point O. Erect a perpendicular to AB from O towards C. If C is not on the perpendicular, correct the point O by moving it by the distance d between C and the perpendicular.

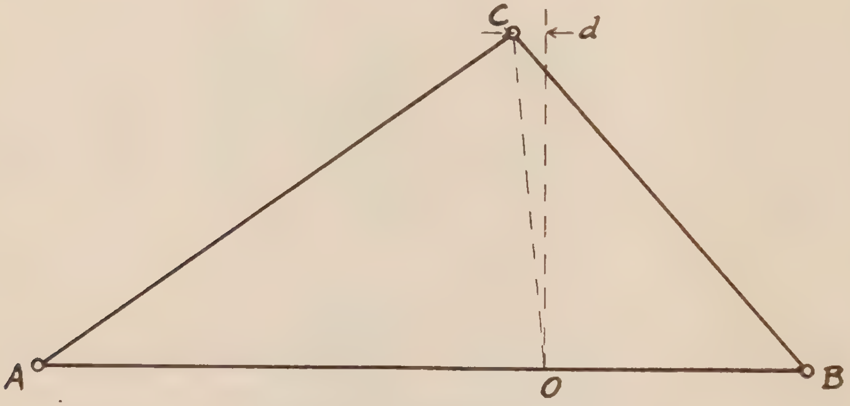

Fig. 6.—Determining the altitude of a triangle

Of an n-sided polygon. The area of an n-sided polygon is the sum of the areas of the triangles into which the polygon may be divided.

Of an irregularly bounded figure. The area of a figure with an irrgular side may be found by summing up the areas of the trapezoids into which the figure may be divided.

Set a base line through, or by the figure. From the base line erect perpendiculars to the bending points of the boundaries of the figure. Following the course of the boundaries of the figure in a clockwise direction, and supposing all courses due west as negative and courses due east as positive, the areas of trapezoids formed by the base line, the two adjacent perpendiculars, and a course shall be positive or negative depending on the sign that the course carries. The difference between the negative and positive areas is the area of the irregularly bounded figure.

Extension of lines

The extension of lines through an obstacle when (1) the two known stations are visible from each other and (2) the two known stations are not visible from each other are common problems in fencing, lining, and orchard work.

1. Stations visible from each other. Suppose A and B are the known stations. (See figure 7.) Erect perpendicular BC on AB from B. Then erect perpendicular CD on BC from C. Produce CD until the obstacle is passed. Then erect perpendicular DE on CD from D. DE must be made equal to BC. From E erect a perpendicular. This is the required extension of AB.

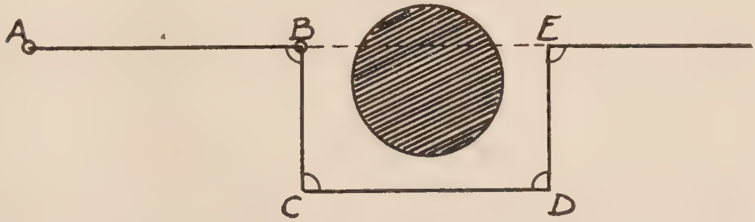

Fig. 7.—Extending a line through an obstacle when known stations are on the same side of the obstacle

2. Stations not visible from each other. Suppose A and B are the known stations. (See figure 8.) From A project a line, AC, passing by the obstacle. From AC, erect a perpendicular to B. Then from a point D on line AC, erect perpendicular DE, so that AC/CB equals AD/DE. Then erect another perpendicular from a point F on line AC to G, so that AC/CB equals AF/FG. Points A, G, E, and B are then all in line.

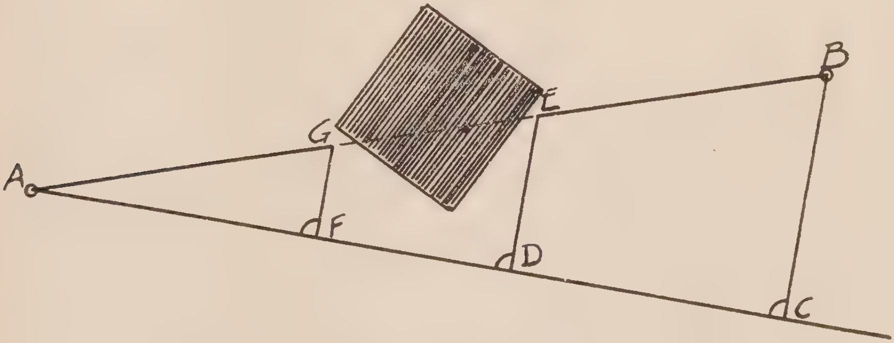

Fig. 8.—Setting a straight line between two stations with an obstacle between

Other problems

The various uses of the surveyor's staff are evident. The staff is well-suited to problems where the erection of perpendiculars is desired.

A COMPARATIVE STUDY OF THE COST OF GROWING AND FATTENING BARROWS, SPAYED FEMALES, AND GILT PIGS FOR MARKET[1]

VALERIANO S. ONG

Barrows, spayed females, and gilts are raised and fattened for sale. But so far as the writer is aware, no study has been made in this country to determine which of these groups of animals is most profitable to raise for market purposes.

Past work on the subject

Henry and Morrison (1922) state that no appreciable difference in the rate of growth of gilts and barrows has been observed. Young pigs have a greater capacity for consuming feed than older ones.

Mumford (1926) states that the castration of male pigs results not only in profoundly influencing the breeding function of the animal but in causing marked bodily change. The removal of the testes influences the physiological constitution of the animal. He further asserts that oxen grow larger and heavier than the uncastrated bull. The same result is obtained in capons which grow to a much greater weight than the normal male. He also states that the removal of ovaries (spaying) of the female is followed by phenomena similar to those observed in the castrated male. Like the male, the disposition becomes quieter and the general physiological condition of the animal favors more rapid laying on of fat.

Sumulong (1925) concludes that castration tends to cause a moderate acceleration of growth in body weight, body length, height, and body circumference. The acceleration in these directions, however, does not occur simultaneously nor immediately after the operation; it appears that the increase in body length and height begins to manifest itself only when the castrated animal is approaching the age of maturity, and the increase in body weight and body circumference only when it has reached or passed the age of maturity.

Object of the experiment

The object of this experiment was to determine the cost of growing and fattening hogs for the market and to obtain information on the comparative profitableness in raising barrows, spayed females, and open gilts.

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[1] Thesis presented for graduation, 1929, with the degree of Bachelor of Science in Agriculture No. 296. Experiment Station contribution No. 616. Prepared in the Department of Animal Husbandry under the direction of Dr. Mariano Mondoñedo.

Time and place of the work

This experiment was conducted in the Public Breeding Station of the Department of Animal Husbandry, Los Baños, Laguna. The experiment was started on November 12, 1927. It was divided into 70-day periods to facilitate the determination of the cost of production at different ages. The first period ended on January 21, 1928; the second, March 31; the third, June 9; and the fourth, August 18. The fifth or the last period ended on September 8, 1928, with lot I; September 15, 1928, with lot II; September 29, 1928, with lot III.

MATERIALS AND METHODS

Materials used

Animals. The experiment was started with 15 weanling pigs purchased in the market at Calamba. In the course of the experiment, on February 4, 1928, two pigs about two and one-half months old, taken from the College herd, were added to lot II to replace two pigs that had died. The pigs were fairly uniform in size and condition when the experiment was begun. In appearance they were Berkshire grades.

Feeds used. From November 12, 1927, to January 7, 1928, the ground corn was used, but during the remaining part of the experiment shelled corn was given.

During the entire period of the experiment, the same ration and mineral mixture was used.

The ration used consisted of:

Corn	35 parts
Rice bran	45 parts
Copra meal	20 parts
Total	100 parts

One per cent of a mineral mixture consisting of 45 parts of corn cob charcoal and 45 parts of common salt and 10 parts of air-slaked lime was added to the ration. About two kilograms of cassava roots were given every day for the first two months. The average prices per kilogram of the concentrates during the experiment were:

	1927	1928
	pesos	*pesos*
Corn	0.067	0.081
Rice bran	0.053	0.064
Copra meal	0.053	0.069
Cassava	0.020	0.020

Methods used

Allotment of pigs. There were three lots in this experiment. The pigs used in lot I were castrated males (barrows); in lot II, spayed females;

and in lot III, gilts. The spaying was done during the first two periods. On December 15, 1927, pigs 303 and 304 were spayed on December 19, pigs 311, 313, and 317 were spayed, and on March 18, pigs 223 and 330 were spayed.

Duration of the experiment. The duration of the test depended upon the rapidity of growth; the goal was for the animals to attain 80 kilograms live weight. At this weight, they were considered to be in finished condition for the market.

Weighing. At the beginning of the experiment, each pig used was weighed for three consecutive days and the average was taken as the initial weight. At the close, the three daily weighings were repeated, the average being the closing weight. Individual weighings were taken and recorded weekly. The weights were taken between 2:00 and 3:00 p. m., before the pigs received their evening meal.

Cost factors

Labor cost. The actual number of hours spent in the care of the 14 pigs was used in the computation of labor cost, which was based on 10 centavos an hour, the regular student labor wage rate. About 2 hours and 15 minutes daily were spent in the care of the three lots. In field practice a larger number of animals may be cared for in that time, so that the 2 hours and 15 minutes consumed in the care of the 14 animals could be reduced to about one hour daily.

Interest and insurance on the value of the animals. Following the method of computation by Smith (1923), interest at the rate of 6 per cent and risk at the rate of 2 per cent were taken from the average value of each animal. The average value of the animal was obtained by adding the purchase price of the weanling pig at the beginning of the test to the value of the finished pig and dividing the sum by 2.

Interest at the rate of 6 per cent, depreciation at 10 per cent, and insurance at 2 per cent on general equipment were based on the actual value of the hog house (₱700) and fences (₱76) used. The pigs used in this experiment constituted three-sixteenth of the total herd so that only that proportion was charged against the 14 pigs which finished the test. The charge against these pigs was divided by 14 to determine the amount chargeable to each pig.

Pasture cost. The land used for pasture was valued at ₱500 a hectare rented at the rate of ₱30, or 6 per cent, per annum. The actual cost of preparing the land, planting, and cultivating the camote crop for pasture was ₱53.32 a hectare.

Miscellaneous cost. Expenses for drugs, such as purgative, vermifuge, creoline and mineral mixtures.

Feed cost is based on the actual amount of feed consumed during the entire period of fitting the pigs and the average purchase price thereof during the same period.

Care and management

The three lots of pigs were dry fed part of the time, and pastured at other times. The pigs were allowed to stay in the pasture for two hours daily from 8:00 to 10:00 in the morning, and then were driven to lots bare of vegetation. The pigs were given fresh water and a bath at noon every day. During stormy weather they were kept in the hog house. All treatment given to animals was the same. The different lots ran together and were separated only at meal time. The hogs were trained to go to their respective feeding pens.

RESULTS

It may be noted in table 1 that in the first period of the test, lot I (barrows) made the most rapid growth, lot III (gilts), second; and lot II (spayed) was poorest. In the second period, lots I and III were about the same, with lot II again the poorest. In the third period there were no marked differences among the three lots, except that lot II made the most rapid gain. In the fourth period lot II continued to be in the first place closely followed by lot I with lot III last.

Table 2 shows the amount of feed consumed by lots during the different periods of the test.

Table 3 gives the results obtained during the entire period of the test. From the standpoint of economy in production the three lots were practically the same.

In table 4, it may be seen that all three lots made significant net profit. Lot I gave the highest with a net profit of ₱10.20; lot II had a net profit of ₱9.47; and lot III, ₱9.90.

It may be seen in table 5 that in the three lots, the proportion of feed cost, labor cost, and other expenses, which constitute the total cost of production, was practically the same. The three lots averaged ₱21.58, or 72.53 per cent, for feed cost, ₱4.77, or 16.03 per cent, for labor cost; and ₱3.41, or 11.44 per cent, for other expenses. Taking all the lots, the average total cost of bringing a weanling pig weighing from 7½ to 10½ kilograms to 80 kilograms weight was ₱29.76.

DISCUSSION OF RESULTS

It may be noted that in the first period of the experiment lot I made the most rapid growth. This was probably because the animals in this lot at the beginning of the experiment were slightly heavier than those of the other two lots. The female animals in lot II were spayed during the experiment; to this probably their slow growth in the first period may be attributed. During the second period the increase in weight in this lot was greater, probably because the animals operated upon had fully recovered.

There were reasons for not spaying the female pigs in lot II before the experiment. The unsexing of female pigs should not be made at as early an age as is recommended in castration, as it is difficult to locate the ovaries because they are very small. The first appearance of oestrum does not come until the animal is four or five months old. Experience in the College shows that it is best to spay at the age of three to four months.

It may be also noted in table 1 that in the fourth period, the spayed lot outgrew the gilt lot. The poor result made by the gilt class was mainly due to the occurrence of oestrum every three weeks. Every time a gilt in this lot came in heat, she lost her appetite, hence her gain as shown at the following weighing would fall below normal.

In table 2 it may be noted that the cost of the gains made is cheapest in the early period; this tended to increase in the later periods.

It may be seen in table 4 that the most important item of cost in producing pork is feed. Adding to the cost of growing and fattening the purchase price of the weanlings brings the total cost of an 80 kilogram pig to ₱38.43 among the barrows, ₱38.77 for the spayed animals, and ₱38.23 for gilts. The average profit for barrows is ₱10.20; for spayed pigs, ₱9.47; and ₱9.90 for gilts.

From the practical, or the hog feeder's point of view, the net profit realized from the 15 weanlings purchased, is the difference between the selling price of the finished market weight of the pigs and the expenses entailed in the course of feeding including the purchase price of the pigs. In this experiment the figures are:

Selling price of 1126.3 kg. of pork at ₱0.60 a kg.		₱675.78
Total cost:		
a. Purchase price of 15 weanling pigs........	₱121.00	
b. Total expenses of feeding.............	₱416.43	₱537.43
Total net profit......................		₱138.35
Average net profit for each pig...............		₱ 9.88

Summarizing the final results as presented in tables 3 and 4, it may be seen with the three classes of pigs that in almost every respect there was practically no difference in growing and finishing them for market purposes. Lot III consisting of gilts seemed to be the least efficient. It took lot III the longest period to become fit for the market. The element of time is an important factor to consider in business enterprises which deal with live products that are highly susceptible to disease. The shorter the period required to turn out a finished product the less the risk.

In this experiment the barrows (lot I) were only as efficient as the other two classes. This is contrary to what was expected as it is widely accepted among hog growers that barrows as a class are the most profitable for fattening purposes. While this paper was being written, pig 298, one of the 5 barrows in lot I, was butchered on February 16. On examination of the carcass it was found to be a cryptorchid, virtually a boar. These findings may explain why he was the slowest in the lot to gain in weight and why he was observed to serve the gilts that were with him in the herd. Had it not been for this pig, the remaining four which were real barrows would have made the required average weight of 80 kilograms in 269 days instead of 301, gaining weight at the rate of 0.27 kilogram a day for each pig.

SUMMARY OF RESULTS AND CONCLUSIONS

1. It took the barrow lot about 301 days, the spayed lot 270 days, and the gilt lot 315 days of feeding to weigh 80 kilograms live weight from weanling to 80-kilogram size. Computing from birth the time to reach this stage of finish would be 376 days for the barrows, 345 for the spayed pigs and 390 for the gilts.
2. The average cost per pig to produce pork from the barrow class was ₱38.23; spayed class, ₱38.77; and gilt class, ₱38.23.
3. The most important item of cost in the production of pork is feed.
4. The average feed cost of finishing the weanling pig to 80-kilogram size for the whole lot of pigs fed was ₱29.76, of which ₱21.58 was feed cost (73 per cent); ₱4.77, labor cost (16.03 per cent); and ₱3.41 for other expenses (11 per cent). The last item includes interest, depreciation, and insurance on general equipment, interest and risk on the average value of the pig and miscellaneous items as drugs, etc.
5. In the cost of production there was practically no difference between the three classes of hogs in growing and finishing them for market purposes.

However, in the length of time required to attain the required finish there is a significant difference of 30 days in favor of fattening unsexed pigs.

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TABLE 1

Weekly total and average weights of pigs in each lot

Date of weighing	LOT I		LOT II		LOT III	
	Total weight	Average weight	Total weight	Average weight	Total weight	Average weight
	kg.	*kg.*	*kg.*	*kg.*	*kg.*	*kg.*
First period						
Initial weight	52.0	10.40	37.0	7.40	37.0	7.40
November 19	57.3	11.46	37.4	7.88	38.5	7.70
26	58.8	11.76	43.9	8.78	42.3	8.46
December 3	62.5	12.50	45.5	9.10	44.3	8.86
10	69.7	13.94	48.5	9.70	48.5	9.70
17	73.4	14.68	49.4	9.88	51.6	10.32
24	76.9	15.48	50.7	10.14	54.8	10.96
31	82.7	16.54	54.5	10.90	58.2	11.64
January 7	87.2	17.44	58.1	11.62	64.1	12.82
14	89.1	17.82	42.6	10.65	66.3	13.26
21	94.4	18.88	42.6	10.65	68.2	13.64
Second period						
January 28	99.8	19.96	33.4	11.13	78.8	15.36
February 4	104.7	20.94	65.8	13.13	79.8	15.96
11	111.2	22.24	72.6	14.52	85.9	17.18
18	117.4	23.48	76.1	15.22	93.4	18.68
25	126.6	25.20	81.0	16.20	97.5	19.50
March 3	130.2	26.04	85.5	17.10	104.8	20.96
10	139.6	27.92	90.4	18.08	111.9	23.38
17	139.8	27.96	93.4	18.68	121.0	24.20
24	149.7	29.94	97.3	19.46	125.5	25.10
31	156.7	31.34	101.9	20.38	131.0	26.20
Third period						
April 7	167.3	53.44	101.8	25.50	144.6	28.92
14	167.7	33.54	108.2	27.05	152.9	30.50
21	177.3	35.46	113.0	28.25	160.4	32.08
28	189.4	37.88	125.4	31.35	172.8	34.56
May 2	203.6	40.72	137.8	34.54	184.2	36.84
12	212.8	42.56	147.6	46.90	198.0	38.60
19	221.0	44.20	154.2	38.35	204.3	40.86
26	233.7	46.74	161.4	40.35	212.8	42.56
June 2	246.3	49.26	172.5	43.12	227.3	45.46
9	263.4	52.68	189.4	47.35	239.8	47.96
Fourth period						
June 16	274.1	54.82	263.2	50.80	252.2	50.32
23	288.7	57.74	210.0	52.50	262.1	52.42
30	303.0	60.60	218.9	54.73	269.4	53.88
July 7	312.4	62.48	230.5	57.55	278.3	55.66
14	317.2	63.41	236.2	59.05	286.0	57.20
21	328.0	65.50	246.2	61.55	289.8	57.56
28	339.3	67.86	259.4	64.85	304.3	60.86
August 4	346.9	69.38	266.0	66.50	318.7	62.94
11	362.3	72.46	276.1	69.03	323.1	64.62
18	366.5	73.30	279.3	69.83	332.5	66.50
Fifth period						
August 25	378.2	75.64	285.2	71.30	337.8	67.56
September 1	384.4	76.88	293.6	73.43	342.8	68.56
8	403.6	80.72	306.8	76.70	360.2	72.64
15			321.6	80.40	373.1	74.62
22					385.4	77.08
29					401.1	80.22
Gain	351.6	70.32	284.6	71.15	364.1	72.82

TABLE 2

Summary of the cost of feeding each pig for the market at different ages or periods of feeding

PERIOD	LOT I		LOT II		LOT III	
	Feed	Cost	Feed	Cost	Feed	Cos
	kg.	*pesos*	*kg.*	*pesos*	*kg.*	*pesos*
1st 70 days	26.31	1.66	20.89	1.32	34.76	1.56
2nd 70 days	59.36	4.21	33.74	2.39	48.20	3.40
3rd 70 days	80.84	5.73	85.90	6.07	78.20	5.55
4th 70 days	92.32	6.55	102.82	5.83	82.56	5.85
5th period[a]	40.52	2.87	60.32	3.45	84.48	5.99

[a] Fifth period is 21 days in Lot I, 28 days in Lot II, and 35 days in Lot III.

TABLE 3

Summary of results obtained during the whole feeding trial

	LOT I	LOT II	LOT III
	Barrows	Spayed females	Gilts
Number of pigs	5	4[a]	5
Duration of experiment	301 days	270 days	315 days
Total initial weight	52.00 kg.	37.00 kg.	37.00 kg.
Average initial weight	10.40 kg.	7.40 kg.	7.40 kg.
Total final weight	403.60 kg.	321.60 kg.	401.10 kg.
Average final weight	80.72 kg.	80.40 kg.	80.22 kg.
Total gain	351.60 kg.	284.60 kg.	364.10 kg.
Average gain per pig	70.32 kg.	71.15 kg.	72.82 kg.
Average daily gain per pig	.234 kg.	.263 kg.	.231 kg.
Total grain consumed	1496.64 kg.	1181.24 kg.	1590.09 kg.
Total cost of grain consumed	₱105.09	₱ 83.75	₱112.82
Grain feed consumed per kgm. gain	4.256 kg.	4.151 kg.	4.367 kg.
Cost of grain to produce 1 kgm. gain	₱ 0.2989	₱ 0.2942	₱ 0.3070
Grain feed consumed per 100 kgm. gain	425.60 kg.	451.10 kg.	436.70 kg.
Cost of grain to produce 100 kgm. gain	₱ 29.80	₱ 29.42	₱ 30.70

[a] Fifth pig died early in the test.

TABLE 4

Cost of pork production by lot

	LOT I	LOT II	LOT III
	Barrows	Spayed females	Gilts
Number of pigs	5	4	5
Duration of test	301 days	270 days	315 days
	pesos	*pesos*	*pesos*
Cost of animals at the beginning of experiment	48.00	36.50	36.50
Average cost of animals at the beginning of experiment	9.60	7.30	7.30
Cost of feeding pigs from weanling to finished condition	105.09	83.75	111.79
Average cost of feeding pigs from weanling to finished conditions	21.25	20.94	22.56
Total labor cost at 3 hours daily at ₱.10 per hour	22.57	20.25	23.62
Interest on the average value of animals at 6%	2.11	3.24	5.20
Risk on the loss of animals	2.28	1.71	2.55
Interest, depreciation and insurance on general equipment	8.13	7.29	8.51
Cost of pasture and rent of land, ¼ Ha. at 6%	2.23	1.76	2.25
Miscellaneous cost	0.75	0.60	0.75
Total expenses	191.16	155.10	191.17
Average total expense per pig (including initial cost)	38.23	38.77	38.23
Gross return from pork of pigs at ₱.60 a kgm.	242.16	192.96	240.66
Average gross return per pig	48.43	48.24	48.13
Total net profit	51.00	37.86	49.49
Average net profit per pig	10.20	9.47	9.90

TABLE 5

Distribution of the total cost of finishing weanling pigs to 80 kilogram pig for market

ITEMS	LOT I		LOT II		LOT III		AVERAGE OF THE LOTS	
	Cost	Percentage	Cost	Percentage	Cost	Percentage	Cost	Percentage
	pesos		*pesos*		*pesos*		*pesos*	
Feed cost	21.25	73.62	20.94	71.52	22.56	72.45	21.58	72.53
Labor cost	4.50	15.63	5.06	17.28	4.73	15.18	4.77	16.03
Other costs[a]	3.10	10.75	3.28	11.20	3.85	12.36	3.41	11.44
Total costs	28.85	100.00	29.28	100.00	31.14	100.00	29.76	100.00

[a] This item of cost includes interest, depreciation and insurance on general equipment, land rents, cost of growing pasture crop, interest and risk on the average value of animals, and miscellaneous expenses.

A STUDY OF TWO METHODS OF PLANTING CORN: WITH CORN PLANTER AND BY HAND[1]

ALBINO P. VARONA

The object of the present work was to compare the planting of corn with a corn planter with the native or hand method and determine which was better adapted to local conditions.

This work was conducted in the Experiment Station fields of the College of Agriculture. The dry-season crop was planted December 3, 1927, and harvested March 22, 1928. The rainy-season crop was planted May 24, 1928, and harvested September 5, 1928.

MATERIALS AND METHODS

Variety

The variety used in this study was the Calauan strain of the Native Yellow Flint because it is popular in the locality. The seeds were taken from the middle of cured ears and were of fairly uniform size.

Procedure of the experiment

In the present work, all crops were given the same treatment, except in methods of planting. The lot used for each season had an area of about 0.4 hectare. The implements used were a single animal plow, spike tooth harrow, a corn planter[2], No. 4 "Queen" Steel Cultivator and Horse Hoe[3], and a Fairbanks portable balance.

The land used for the dry–season planting was a stubble field, of clay loam, well drained and fairly uniform in texture throughout. The first plowing was done November 23, 1927, followed by harrowing. The land was left idle. On December 1, 1927, the field was plowed and harrowed for the second time.

The planting for this season was done on December 3, 1927. The field was divided into two equal lots, one for native planting and the other for use of the corn-planter.

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[1] Thesis presented for graduation, 1929, with the degree of Bachelor of Science in Agriculture from the College of Agriculture No. 299; Experiment Station contribution No. 622. Prepared in the Department of Agronomy under the direction of Assistant Professor Mariano B. Raymundo.

[2] Corn planters which are sold in the Philippines are provided with blank plates so that the desired holes may be made to suit local conditions. A simple alteration is readily made in the plate either for distance of plants or for number of plants to the hill. Alteration may be made also by changing the gears.

[3] The No. 4 "Queen" Steel Cultivator and Horse Hoe is locally known as the Calamba Cultivator. However, the first is the trade name given by the manufacturers.

In the case of native planting, furrows one meter apart were made at an average depth of 15.24 centimeters. The seeds were planted in the furrows 75 to 100 centimeters apart. All the planting by native method were done by hand, dropping three seeds to a hill and covering them with the foot.

For the second lot the Drill Superior No. 4 corn planter was used. The distance between the rows was one meter. The holes of the revolving plate of the corn planter were adjusted so as to drop one seed to the hill, at an average distance of 38 centimeters apart in the row, thus adapting one of the standard drops and distances of the corn planter in the market. This corn planter has a double disc furrow opener and a rear concave drive wheel which closes the furrow. The feed or revolving plate inside the hopper was turned by the drive wheel by means of sprocket and chain. The same planter was used in the rainy-season crop.

The dry-season crop was cultivated twice. The first cultivation was made when the plants were about 30 centimeters high and the second, when they were about 76 centimeters high. No. 4 "Queen" Steel Cultivator and Horse Hoe was used in the first cultivation. The second cultivation was hilling, with a single animal plow.

The crop was harvested by hand March 22, 1928. There were twelve rows to each lot; each row constituted one unit. The ears were husked and the harvest from each unit was graded into first class, second class, third class, and nubbins and damaged ears. The first three classes were marketable, but not the nubbins and damaged ears.

The weights were taken for each grade and expressed in percentages based on the total yield for each lot. A portable Fairbanks balance was used in weighing.

The lot used for the rainy-season crop was plowed and harrowed May 10, 1928, then left idle. May 22, 1928, the field was plowed and harrowed for the second time. The same implements were used for the rainy-season crop as for the dry-season.

The rainy-season planting was done May 24, 1928, closely following the procedure for the dry-season.

When the plants were about 76 centimeters high, they were hilled, using a single animal plow. Owing to lack of labor this crop was cultivated only once.

Harvesting was done September 5, 1928. The procedure of taking data in the dry-season crop was closely followed for the rainy-season crop.

RESULTS AND DISCUSSION

Field observations on the dry–season crop seem to indicate that with both methods germination, growth, and development of the plants and the effect of cultivation were practically the same during the entire season. However, at harvest time a slight difference was observed in the crop. The native method lot had more barren plants and the ears produced were smaller than in the corn-planter lot.

The corn-planter lot of the rainy-season crop exhibited better germination, growth, uniformity, and vigor of plants than the native-method lot. The seed used for this season, as in the dry season, was tested and found to be 95 per cent viable. The actual field germination with the native method was 75 per cent; with the corn-planter method it was 88 per cent, giving a difference of 13 per cent. It was observed before the seeds germinated that at the end of the lot near a creek when the land was not cleared, rats easily located the seeds in the furrow and ate the germs. This damage was the only possible cause of the difference in the percentage of germination. The ears were smaller in the native-method lot than in the corn-planter lot. The number of barren plants was greater in the native-method lot than in the corn-planter lot.

Under the conditions of this test it is evident that one plant to a hill at a distance of 38 centimeters in the row has a better growth than three plants to a hill at an average distance of 87 centimeters. The reason is that during the growing period the one plant to a hill had more food elements than the three plants, which were crowded in a limited feeding area. Montgomery (1920) found that "as the number of plants increased, the size of ear and the number of ears decreased, while the number of barren plants increased". In both seasons the increase in the number of barren plants was largely the cause of the difference in uniformity of yield of the lots.

The dry–season production is shown in tables 1a and 1b. From these tables it may be seen that with the corn–planter method the average production per row was 25.9 ± 0.99 kg., while with the native method it was 22.6 ± 0.71 kg. The difference per row was 3.3 ± 1.22 kg. in favor of the corn-planter method, but this difference is not significant. This season, however, showed a higher average percentage of first (17.95) and second (48.23) classes of ears in the corn-planter method. This average was largely due to bigger, well developed ears and lower average percentage of third class ears (28.47) and nubbins and damaged ears (5.35). With the native method the average percentage was 9.12 of first class, 38.50 of second class, 41.20 of third class, and 11.18 of nubbins and damaged ears.

The rainy-season production is shown in tables 2a and 2b. In this crop the superiority of the corn planter over the native method was more evident. The average row production with the corn planter was 37.0 ± 1.19 kg., while with the native method it was 26.8 ± 1.40 kg., a difference of 10.2 ± 1.83 kg. in favor of the corn planter. This difference is significant. As with the dry-season crop, the corn planter for the rainy season excelled the native method in the first and second classes of ears but had a lower production in the third class and nubbins and damaged ears. The corn-planter method gave the following averages: 10.98 per cent of first class, 31.84 per cent of second class, 43.62 per cent of third class, and 13.56 per cent of nubbins and damaged ears, while the native method gave 3.02 per cent of the first class, 20.06 per cent of the second class, 51.97 per cent of the third class and 24.95 per cent of the nubbins and damaged ears. From these data it is very evident that the corn-planter method, besides producing a higher average yield per row in the rainy-season culture, produced better grades of ears than the native method. This superiority of the corn-planter method over the native method under the same condition is due to the difference in the method of planting, which results in the production of larger, well developed ears.

The cost of operation for each season, as may be seen from table 3, is the same in all items except in planting, cost of seeds and depreciation and interest on the implements used[4]. The item in both dry and rainy-season crops in which the saving was greatest was planting and to some extent the cost of seed because of difference in quantity used. The native planting for the 0.2 hectare cost ₱1.20, while planting with the corn planter for the same area because of its self-furrow opener and closer, and its relatively rapid operation, cost ₱0.43, making a saving of ₱0.77 centavos in favor of the corn planter, in the dry-season crop[5]. With the corn planter the work was done in shorter time with one man than with the native method with two men, one making the furrow and the other planting the seed. Also the corn-planter method used a smaller amount of seed than the native method, making a difference in cost of ₱0.03 for the same area. For the rainy season there was a difference of ₱0.66 in labor in favor of the corn planter and in seed cost of ₱0.04. Because of the larger investment in the corn planter, depreciation, and interest, there was a higher cost of ₱0.03 for the dry season and ₱0.04 for the rainy season. The corn-planter method is nevertheless less expensive than the native method and the gain is due almost entirely to the time saved in planting with the corn planter.

Table 4 is derived from tables 1a, 1b, 2a and 2b, and shows the comparative production of the two methods for each season. It may be seen from table 4, that the dry-season production per hectare had a difference of 197.0 ± 73.20 kg. in favor of the corn-planter method, but this difference was not significant. For the rainy-season crop, the difference in favor of the corn planter was large, the quantity being 609.0 ± 109.80 kg., or 37.83 per cent over that of the native method. This difference is very significant.

The comparative cost of operation of the two methods for each season is shown in table 5. For the dry-season crop there was a saving of ₱0.77 for the corn-planter method or 10.79 per cent less than the cost of the native method. Expressed on hectare basis this would mean a saving of ₱3.65 a hectare which could be evidently considered as profit. The rainy-season

[4] The wages of the laborers ranged from ₱1.00 to ₱1.25 a day. All operations except in planting were shared equally by the two lots.

[5] Depreciation and interest on implements were not included in the planting item but they are combined as a separate item.

crop had a saving of ₱0.66 or 11.16 per cent less than the native method. This would mean a saving of ₱3.30 a hectare. In either season since the saving made was largely due to the planting operation, it will therefore be profitable to use the planter in large-scale production.

SUMMARY OF CONCLUSIONS

Under the present study a few generalizations may be taken from the results obtained.

1. In the rainy-season culture the corn-planter method gave a higher average production per row and larger and better developed ears than the native method.
2. The planting operation with the corn planter consumed less time and labor and cost less than with the native method.
3. The total cost of operation was smaller with the corn-planter method than with the native or hand method.

LITERATURE CITED

MONTGOMERY, E. G. 1920. The corn crops. xvii+347 p., 120 fig. New York: The Macmillan Company.

TABLE 1a

Dry-season production under corn-planter method

ROW	WEIGHT								
	MARKETABLE						NUBBINS AND DAMAGED EARS		TOTAL
	First class		Second class		Third class				
No.	*kg.*	*per cent*	*kg.*	*per cent*	*kg.*	*per cent*	*kg.*	*per cent*	*kg.*
1	11.6	38.41	10.6	35.09	6.6	21.85	1.4	4.65	30.2
2	5.6	18.18	15.6	50.64	7.6	24.67	2.0	6.51	30.8
3	2.2	9.40	10.5	44.87	9.2	39.31	1.5	6.42	23.4
4	0.6	2.43	13.0	52.84	9.4	38.21	1.6	6.52	24.6
5	12.0	34.68	17.0	49.13	4.6	13.29	1.0	2.90	34.6
6	4.6	18.25	12.0	47.61	7.6	30.15	1.0	3.99	25.2
7	6.0	22.22	12.0	44.44	6.8	25.18	2.2	8.16	27.0
8	2.4	9.37	13.0	50.78	8.0	31.25	2.2	8.60	25.6
9	6.4	21.19	14.8	49.00	7.4	24.50	1.6	5.31	30.2
10	2.4	10.81	11.4	51.35	7.6	34.23	0.8	3.62	22.2
11	3.4	17.52	10.4	53.60	4.6	23.71	1.0	5.17	19.4
12	2.2	12.94	8.4	49.41	6.0	35.29	0.4	2.36	17.0
Average..	5.0	17.95	12.4	48.23	7.1	28.47	1.4	5.35	25.9±0.99

TABLE 1b

Dry-season production under native method

ROW	WEIGHT								
	MARKETABLE						NUBBINS AND DAMAGED EARS		TOTAL
	First class		Second class		Third class				
No.	*kg.*	*per cent*	*kg.*	*per cent*	*kg.*	*per cent*	*kg.*	*per cent*	*kg.*
1	1.3	5.24	11.0	44.35	11.2	45.17	1.3	5.24	24.8
2	3.6	15.06	13.2	55.23	5.5	23.01	1.6	6.70	23.9
3	3.2	10.95	15.8	53.76	8.8	30.13	1.4	5.16	29.2
4	3.4	11.72	14.0	48.27	10.8	37.24	0.8	2.77	29.0
5	3.9	17.77	10.2	46.36	6.4	29.09	1.5	6.78	22.0
6	2.4	10.71	8.6	38.39	9.7	43.30	1.7	7.60	22.4
7	2.1	11.35	7.9	42.70	6.0	32.43	2.5	13.52	18.5
8	1.4	6.51	6.6	30.69	9.2	42.79	4.3	20.01	21.5
9	1.0	4.52	5.5	24.88	11.8	53.39	3.8	17.21	22.1
10	1.2	6.00	4.6	23.00	11.0	55.00	3.2	16.00	20.0
11	1.0	5.49	4.2	23.07	10.2	56.04	2.8	15.40	18.2
12	0.8	4.16	6.0	31.25	9.0	46.87	3.4	17.72	19.2
Average..	2.1	9.12	9.0	38.50	9.1	41.20	2.4	11.18	22.6±0.71

TABLE 2a

Rainy-season production under corn-planter method

ROW	WEIGHT								
	MARKETABLE						NUBBINS AND DAMAGED EARS		TOTAL
	First class		Second class		Third class				
No.	*kg.*	*per cent*	*kg.*	*per cent*	*kg.*	*per cent*	*kg.*	*per cent*	*kg.*
1	8.0	21.24	14.8	38.34	12.0	31.08	3.8	9.34	28.6
2	3.2	10.44	11.2	35.44	12.6	39.87	4.6	14.25	31.6
3	5.6	14.73	10.8	28.42	15.8	41.57	5.8	15.28	38.0
4	1.6	5.12	6.6	21.15	16.8	53.84	6.2	19.89	31.2
5	1.6	4.49	11.5	32.30	18.0	50.56	4.5	12.65	35.6
6	6.2	16.06	16.8	43.52	9.6	24.89	6.0	15.53	38.6
7	4.8	10.61	15.6	34.51	19.0	42.03	5.8	12.85	45.2
8	2.6	8.41	8.3	26.86	15.9	51.45	4.1	13.28	30.9
9	2.4	7.59	9.4	29.74	16.1	50.63	3.7	12.04	31.6
10	4.8	11.82	11.0	27.09	20.0	49.26	4.8	11.83	40.6
11	2.8	8.83	9.5	29.96	15.6	49.21	3.8	12.00	31.7
12	6.2	12.37	17.4	34.73	19.6	39.12	6.9	13.78	50.1
Average..	4.2	10.98	11.9	31.84	15.9	43.62	5.0	13.56	37.0±1.19

TABLE 2b

Rainy-season production under native method

ROW	WEIGHT								
	MARKETABLE						NUBBINS AND DAMAGED EARS		TOTAL
	First class		Second class		Third class				
No.	*kg.*	*per cent*	*kg.*	*per cent*	*kg.*	*per cent*	*kg.*	*per cent*	*kg.*
1	0.0	0.00	1.6	10.95	7.8	53.42	5.2	35.63	14.6
2	0.9	2.65	8.7	25.66	17.1	50.44	7.2	21.25	33.9
3	0.7	2.45	5.3	18.40	15.2	52.77	7.6	26.40	28.8
4	0.6	2.06	5.5	18.96	16.6	57.24	6.3	21.74	29.0
5	1.0	2.92	6.5	19.00	17.2	50.29	9.5	27.79	34.2
6	1.8	5.94	7.4	24.42	14.4	47.52	6.7	22.12	30.3
7	1.3	4.37	6.4	21.54	15.9	53.53	6.1	20.56	29.7
8	1.2	4.01	6.3	21.07	16.0	53.51	6.4	21.41	29.9
9	0.3	1.41	2.1	9.90	12.3	58.01	6.5	30.68	21.2
10	1.6	4.61	9.3	26.80	15.5	44.66	8.3	23.93	34.7
11	0.1	0.48	4.4	21.10	11.7	56.25	4.6	22.17	20.8
12	0.8	5.40	3.4	22.97	6.8	45.94	3.8	25.69	14.8
Average..	0.9	3.02	5.6	20.06	13.9	51.97	6.5	24.95	26.8±1.40

TABLE 3

Cost of operation

ITEMS	DRY SEASON				RAINY SEASON			
	NATIVE		PLANTER		NATIVE		PLANTER	
	Actual	Per Ha.	Actual	Per Ha.	Actual	Per Ha.	Actual	Per Ha.
	pesos	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*
Preparation of land	3.10	15.50	3.10	15.50	2.28	11.40	2.28	11.40
Planting	1.20	6.00	0.43	2.15	1.13	5.65	0.47	2.35
Cultivation and weeding	1.21	6.05	1.21	6.05	0.73	3.65	0.73	3.65
Cost of seeds	0.15	0.75	0.12	0.60	0.16	0.80	0.12	0.60
Harvesting	2.00	10.00	2.00	10.00	2.12	10.60	2.12	10.60
Depreciation and interest on implements	0.24	1.20	0.27	1.35	0.15	0.75	0.19	0.95
Total	7.90	39.50	7.13	35.65	6.57	32.85	5.91	29.55

The price of corn for seed at the time of purchase was ₱0.16 a ganta.

$$\text{Depreciation per day} = \frac{\text{Cost of implement}}{\text{Maximum number of years that the implement will last multiplied by the number of days used in a year.}}$$

$$\text{Interest per day} = \frac{\text{Cost of implement multiplied by the rate of interest.}}{\text{Number of days used in a year.}}$$

Example, the native plow:

$\frac{₱15.00}{5\times 100}\times 3.83 = ₱0.115$, depreciation for 3.83 days (34.5 hours).

$\frac{₱15.00\times 10\%}{100}\times 3.83 = ₱0.057$, interest for 3.83 days (34.5 hours).

The total depreciation and interest = ₱0.115 + ₱0.057 = ₱0.172.

In the College of Agriculture nine working hours equals one day. The other depreciation rates and interest were computed in the same manner and the data were obtained from the Department of Agronomy.

TABLE 4

Comparative production of each method for each season

AREA	DRY SEASON				RAINY SEASON			
	PLANTER	NATIVE	DIFFERENCE[a]		PLANTER	NATIVE	DIFFERENCE	
Ha.	*kg.*	*kg.*	*kg.*	*per cent*	*kg.*	*kg.*	*kg.*	*per cent*
0.2	310.2	270.8	39.4±14.64	14.54	443.7	32.19	121.8± 21.96	37.83
1.0	1551.0	1354.0	197.0±73.20	14.54	2218.5	1609.5	609.0±109.80	37.83

[a] The difference is insignificant.

TABLE 5

Comparative cost of operation of each method for each season

AREA	DRY SEASON				RAINY SEASON			
	NATIVE	PLANTER	DIFFERENCE		NATIVE	PLANTER	DIFFERENCE	
Ha.	*pesos*	*pesos*	*pesos*	*per cent*	*pesos*	*pesos*	*pesos*	*per cent*
0.2	7.90	7.13	0.77	10.79	6.57	5.91	0.66	11.16
1.0	39.50	35.65	3.85	10.79	32.85	29.55	3.30	11.16

THE EFFECT OF TAPPING COCONUT PALMS FOR TODDY ON THE PRODUCTION OF COPRA AND OIL[1]

FLORENCIO A. SOLIVEN
Of the Department of Agricultural Chemistry

It has been repeatedly observed that coconut palms which are tapped for toddy bear nuts abundantly the year after the tapping is stopped and for a few years thereafter. Tapping seems to have a stimulative effect on the productivity of the palms, but this effect is only temporary; after one or two years the productivity slowly decreases. No authentic record is available on the stimulative effect of tapping on the amount and quality of copra and oil produced except one report of observations in the Federated Malay States. There have been, however, casual observations relative to nut production made by several coconut planters in the province of Laguna, Philippine Islands, and in the Federated Malay States.

Those who are primarily interested in the marketing of nuts are very little concerned as to whether or not the nuts they produce contain a high percentage of copra, their goal being the production of as large a number of nuts per unit of area as possible. But planters interested in the production of copra desire to produce nuts that will yield the largest quantity of dry meat as well as a large production of nuts per unit of area. Hence these planters are interested in the question as to whether the tapping produces a stimulative effect on the production of nuts. The copra producers are interested in the effect of tapping only if it is accompanied with increased yield of copra as well as in number of nuts. The amount of oil produced is of little concern to the copra producers, since they market their product by weight and not by content of oil, although preference is usually given by buyers to firms known to sell a product that yields a large quantity of oil.

Jack and Dennet[2] (1925) found an average loss of 20.60 grams of copra to a nut as a result of tapping. Now copra is principally bought by the weight; the quality is judged by the presence of moulds and fungi and on the moisture content. The criterion of oil content is not used. Oil mills or oil producers, therefore, are at the mercy of the copra producers, who are dependent on the coconut growers for the value of their raw materials. Hence decrease in the amount of oil obtainable in the copra means much to

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[1] Experiment Station Contribution No. 612. Read before the Los Baños Biological Club, January 31, 1929. Received for publication June 28, 1929.

[2] Jack, H. W. and J. H. Dennett, 1925. The effect of tapping coconut palms for toddy on copra and oil produced from subsequent fruiting. The Malayan Agricultural Journal XIII, 302-308.

oil producers. Jack and Dennett found that in the Federated Malay States a loss of approximately 22 grams of oil from each nut or a loss of about 180 pounds oil for every ton of copra milled was due to the operation of tapping for toddy.

Through the courtesy of Mr. Felipe Montesines, manager and principal stockholder of La Sampaguita, a coconut distillery in Lilio, Laguna, nuts were collected from some of the trees around the factory. At the time the nuts were gathered there were nuts available from trees which had not been tapped for one year, two years, and for four years and from trees which had never been tapped. Nuts for the study were collected from these four different groups of trees. The trees from which the samples were gathered were all from one part of the plantation, hence apparently had had the same care.

TABLE 1

Composition of nuts obtained from untapped coconut palms

WT. WHOLE NUT	WT. SHELL	PERCENTAGE OF SHELL	WT. FRESH MEAT	PERCENTAGE FRESH MEAT	PERCENTAGE MOISTURE IN MEAT	WT. DRY MEAT	PERCENTAGE DRY MEAT	PERCENTAGE OIL IN MEAT		WT. OIL	THICKNESS OF MEAT
								Fresh	Dry		
grams	*grams*		*grams*			*grams*				*grams*	*cm.*
689.0	137.6	20.00	530.9	77.05	54.15	243.4	35.33	34.97	80.62	196.3	1.40
637.4	128.7	20.19	372.8	58.48	49.38	188.7	29.61	36.27	71.65	135.2	1.20
612.5	135.3	22.09	344.1	56.18							0.93
645.5	174.9	27.10	359.8	55.74	57.10	154.4	23.92	32.13	74.89	155.9	1.20
559.4	114.2	20.41	433.8	77.55	55.82	191.1	34.26	37.60	85.10	163.1	0.83
666.9	158.7	23.80	437.0	65.52							1.10
613.0	150.0	24.47	441.0	71.94	51.21	215.2	35.10	35.04	71.81	154.5	1.08
558.6	100.2	17.94	322.3	57.69	48.29	166.7	29.84	37.92	73.33	122.2	1.20
551.5	175.2	31.77	301.5	54.66	47.54	158.2	28.68	37.41	71.31	112.8	1.10
636.5	162.8	25.58	358.7	56.35	50.18	178.7	28.08	37.60	75.47	134.9	1.02
680.0	147.8	21.74	304.0	44.70	48.44	156.7	23.05	37.19	72.12	113.0	1.20
676.0	148.7	22.00	402.2	57.47	59.22	123.8	18.31	34.08	83.57	103.5	1.00
647.8	154.9	23.91	338.7	52.28	47.20	178.9	27.61	31.69	60.01	107.3	1.20
595.0	155.2	26.08	366.3	61.56	45.49	199.7	33.56	36.40	66.77	133.3	1.10
538.0	122.5	22.77	303.5	56.41	47.61	159.0	29.55	38.64	73.75	117.3	1.26
Average		22.74	380.1	60.82		177.9	32.23	35.91	73.87	134.6	1.12

THE PREPARATION OF THE SAMPLES AND THE DETERMINATION OF THE OIL CONTENT

When the nuts were gathered they were matured, as was shown by the husk being well dried. As work could not be started at once the nuts were stored in one corner of the laboratory for a period of about a week. This delay permitted the husks to dry completely. At the end of the week the nuts were husked, weighed, and the weight recorded. The nuts were then opened. As it is difficult to obtain quantitatively the weight of water, it was deemed best to report the amount of water by reckoning the loss in weight after the water had been thrown away. The difference between the weight of the unopened nuts and that of the opened nuts is considered the weight of the water in the nut.

With the aid of a cork borer with a diameter of about one centimeter, borings were taken from each of the opened nuts, five from each of the halves. The thickness of each boring and the average of the measurements taken are recorded in tables 1 to 4. As may be seen in the tables, only the average from the ten borings from each nut was recorded, it being deemed unnecessary to record the individual borings.

TABLE 2

Composition of nuts from trees which had not been tapped for one year previous to time of collection of samples

WT. WHOLE NUT	WT. SHELL	PERCENTAGE SHELL	WT. FRESH MEAT	PERCENTAGE FRESH MEAT	PERCENTAGE MOISTURE IN MEAT	WT. DRY MEAT	PERCENTAGE DRY MEAT	PERCENTAGE OIL IN MEAT		WT. OIL	THICKNESS OF MEAT
								Fresh	Dry		
grams	*grams*		*grams*			*grams*				*grams*	*cm.*
647.00	141.2	21.8	370.5	57.26	50.96	181.7	28.08				1.10
639.00	141.6	22.1	345.9	54.13	54.14	158.6	24.82	31.31	67.88	107.7	2.33
567.00	148.1	26.1	375.3	66.19	50.47	185.9	32.73				1.33
730.00	154.1	21.1	346.6	47.47	52.32	166.0	22.63	32.90	68.71	109.0	1.20
754.00	144.7	19.1	407.6	54.05	48.35	210.5	27.92				2.30
761.00	145.3	19.0	331.7	43.58	51.17	162.0	21.28	27.10	55.50	89.9	1.15
523.00	131.6	25.1	296.3	56.65	52.65	140.3	24.93				1.35
751.90	157.2	20.9	348.5	46.34	53.10	163.5	21.73	23.69	50.51	82.6	1.15
527.20	126.5	23.9	387.8	73.55	47.18	204.8	38.85	31.74	60.09	123.1	1.20
593.10	141.8	23.9	374.4	54.69	51.83	180.4	26.34	24.74	51.36	92.6	0.92
704.40	151.2	21.4	382.6	54.31	50.76	188.4	26.74	34.08	69.21	130.4	1.10
701.00	148.9	21.2	448.6	63.96	51.29	218.5	31.15	30.42	62.45	136.5	1.26
821.00	148.7	18.1	324.3	39.50	53.47	150.9	18.38	25.96	55.79	84.2	1.20
854.00	163.3	19.1	394.2	46.15	45.39	215.3	25.20	29.48	53.98	116.2	1.03
Average.		21.7	366.9	54.13		180.5	26.48	29.14	59.55	107.2	1.33

The borings from each of the nuts were passed through a meat grinder. Triplicate determinations of the moisture content of each of the nuts were made and the average for each of the nuts recorded in tables 1 to 4.

The residue coming from the determination of moisture was used for the estimation of oil by means of the Soxhlet Extractor using dry ethyl ether as a solvent. The loss in weight caused by the treatment was reckoned as the weight of oil in the sample. The average of the determination from each of the nuts is shown in tables 1 to 4.

The meat left attached to the shell was next grated, using a native grater. The shells were then weighed separately so that the weight of the meat for each nut could be calculated. The measurements were recorded in tables 1 to 4.

The oil in the grated meat together with the meat left for the estimation of the oil content of the individual nut was extracted by the usual native method of rendering oil from coconut meat. The oil thereby obtained was used in the determination of the suitability of the oil for culinary purposes.

TABLE 3

Composition of nuts from coconut palms which had not been tapped for two years previous to time of collection of samples

WT. WHOLE NUT	WT. SHELL	PERCENTAGE SHELL	WT. FRESH MEAT	PERCENTAGE FRESH MEAT	PERCENTAGE MOISTURE IN MEAT	WT. DRY MEAT	PERCENTAGE DRY MEAT	PERCENTAGE OIL IN MEAT		WT. OIL	THICKNESS OF MEAT
								Fresh	Dry		
grams	*grams*		*grams*			*grams*				*grams*	*cm.*
885.3	182.5	20.72	418.7	47.29	53.01	196.8	22.22	25.91	55.14	108.5	1.30
810.1	150.0	18.51	394.5	48.69	53.98	181.6	22.40	28.08	61.01	110.7	1.33
900.7	185.7	20.61	449.7	49.92	53.12	210.8	23.40	24.27	51.77	109.1	1.32
990.6	183.1	18.48	420.4	42.43	53.36	196.1	19.79	28.41	60.91	119.4	1.20
971.8	168.7	17.36	457.7	47.09	55.20	249.9	21.10	27.47	61.31	153.2	1.33
869.6	155.0	17.82	466.5	53.64	57.76	197.1	22.66	21.11	49.98	98.5	1.32
678.5	171.7	19.74	343.7	50.65	56.18	150.6	22.19	24.51	55.93	84.2	1.45
911.0	165.7	18.18	449.9	49.38	54.62	204.2	22.41	28.16	62.05	126.7	1.40
964.5	177.6	18.41	482.5	50.00	55.82	128.8	22.09	25.45	57.68	74.3	1.42
993.0	197.1	19.84	438.4	44.14	54.12	155.3	20.25	26.95	58.74	91.2	1.24
872.2	183.5	21.03	447.9	51.35	54.91	202.0	23.15	26.90	59.65	120.5	1.40
948.8	185.3	19.52	445.3	46.93	57.21	190.5	20.08	25.68	60.01	143.6	1.30
808.0	143.4	17.74	361.7	47.24	55.65	160.4	20.93	28.24	63.67	102.1	1.40
788.6	163.6	20.74	272.9	34.60	49.80	136.9	17.37	29.38	58.52	80.1	1.00
912.5	160.7	17.61	436.5	47.83	57.01	187.7	20.56	28.97	67.38	126.4	1.30
920.6	178.5	19.38	488.4	53.05	59.84	196.1	21.30	21.25	52.91	103.8	1.40
Average.		19.11	423.5	47.76		190.2	21.45	26.24	58.53	109.6	1.33

THE EFFECT OF TAPPING ON THE PRODUCTION OF COPRA

Conclusions made in this study are based upon the work on 13 nuts collected from trees which had never been tapped (A); 14 nuts from trees which had been tapped one year previous to the time of the collection of the samples (B); 16 nuts from trees tapped two years before the time of the collection (C); and 21 nuts collected from trees tapped four years before the collection (D). For convenience, these groups of nuts were designated as A, B, C, and D. The percentage of dry meat was 32.23 per cent in A; 26.48 per cent in B; 21.45 per cent in C; and 20.20 per cent in D. Transposing the percentages obtained into grams of dry copra per nut the following figures are obtained: 177.9 grams for A; 180.5 grams for B; 190.2 grams for C; and 151.6 grams for lot D. Obviously the amount of obtainable copra for every nut increased slightly for the one-year and two-year periods of rest from tapping but decreased considerably for the four-year period. it is to be noted that while the average weight of the meat for each nut in lots B and C are slightly greater than that obtained from untapped trees, A, the difference is insignificant, as judged by the method of probable errors. In the case of the meat from nuts tapped four years before the collection, D, there was found a significant difference between the meat from this source and that from untapped trees, A, the latter being the heavier. Rest from tapping for one year or two years in so far as the result shows does not affect the yield of copra, but as the period is lengthened the effect of tapping is to decrease copra. It would appear then that collecting nuts from trees rested two years after tapping has been stopped will not lessen the normal production of copra from each nut as the buyer might expect. However, Jack and Dennett found that tapping decreased the amount of copra obtainable although the difference lies within the limits of probable error. Using figures obtained from lot D, it was found that there was a decrease of 26.30 grams of dry meat to a nut.

TABLE 4

Composition of nuts gathered from coconut palms which had not been tapped for four years previous to time of collection of samples

WT. WHOLE NUT	WT. SHELL	PERCENTAGE SHELL	WT. FRESH MEAT	PERCENTAGE FRESH MEAT	PERCENTAGE MOISTURE IN MEAT	WT. DRY MEAT	PERCENTAGE DRY MEAT	PERCENTAGE OIL IN MEAT		WT. OIL	THICKNESS OF MEAT
								Fresh	Dry		
grams	*grams*					*grams*				*grams*	*cm.*
826.3	193.7	22.46	344.7	39.97	49.57	173.8	20.16	34.10	67.61	117.5	1.75
739.7	144.2	19.49	352.4	47.64	52.30	168.1	22.72	29.03	60.85	102.3	1.30
734.2	156.2	21.27	241.5	32.89	51.37	174.4	15.99	27.87	57.31	100.0	0.85
815.5	174.4	21.36	260.2	31.90	52.82	122.8	15.05	21.92	46.46	57.0	1.20
755.7	164.4	21.75	350.9	46.43	50.47	174.2	23.00	26.42	53.23	90.5	1.10
787.3	156.4	19.86	329.2	41.81	48.35	170.0	21.59	31.20	60.52	85.8	1.15
748.5	172.7	23.07	306.4	40.93	53.69	141.9	18.95	27.49	59.36	117.0	1.15
835.1	159.0	19.03	440.2	52.71	55.23	197.1	23.60	27.56	61.55	80.6	1.30
670.4	150.2	22.40	269.8	40.24	51.48	130.9	19.52	32.22	64.40	84.3	1.10
795.2	145.6	18.30	424.4	53.37	54.12	194.7	24.49	28.19	61.44	119.6	1.40
775.2	162.2	20.92	266.1	34.32	53.51	123.7	15.96	22.54	50.68	62.7	0.80
622.8	128.2	20.58	319.5	51.30	54.29	146.0	23.45	26.04	56.97	83.2	1.30
760.2	142.8	18.78	258.9	34.05	53.45	120.5	15.85	24.74	53.14	64.0	0.80
789.4	124.8	15.63	409.9	51.34	52.37	195.2	23.94	30.17	63.34	123.7	1.20
650.9	110.9	17.03	340.1	52.25	54.52	154.7	23.76	29.27	64.35	99.5	1.30
636.6	108.2	17.00	334.0	52.46	53.68	154.7	24.30	28.29	61.07	94.5	1.20
683.8	158.4	23.16	255.8	37.40	53.31	119.4	17.46	28.05	60.08	71.7	0.90
725.6	162.4	22.38	395.5	54.50	51.02	197.7	26.67	20.48	40.98	81.0	1.10
720.1	160.5	22.28	250.4	34.77	59.47	111.3	14.09	25.16	56.47	63.0	0.90
607.1	128.2	21.12	221.8	36.53	56.35	96.4	15.95	27.14	62.17	60.1	0.90
746.5	120.6	16.15	218.3	28.84	46.74	116.2	15.36	30.67	57.60	67.0	0.70
Average.		20.51	318.1	42.76		151.6	20.20	28.18	58.08	88.1	1.08

A hectare of coconut plantation laid out 7×7 meters would have 204 trees to the hectare. On the basis of 30 harvestable nuts a year from each tree, there would be produced 6,120 nuts on the plantation. Casual observation leads to the conclusion that this number of nuts could be increased by tapping, but nothing conclusive can be said in favor of the practice to increase yield of nuts. At any rate the increase in the weight of copra obtainable is insignificant. But it appears that when a longer period of rest is allowed as in this case of four years, there is a decrease of 160,956 grams of dry meat to a hectare of coconut plantation, hence the practice should not be encouraged.

THE EFFECT OF TAPPING ON THE OIL CONTENT

It may be seen from tables 1 to 4 that there is a decrease in the percentage of the oil in nuts from trees that have been tapped. This is in accord with the findings of Jack and Dennet. The percentage of oil expressed on the dry basis for lot A is 73.87 per cent; lot B, 59.55 per cent; lot C, 58.53 per cent; and lot D, 58.08 per cent. If these percentages are transformed into gram weight of oil the following figures are obtained: 134.6 grams for untapped trees; 107.2 grams tapped trees after rest of one year; 109.6 grams after two years' rest and 88.1 grams after four years' rest. Computing the odds of the significance of the differences by the probable error method, it is found that there is actually a loss of oil in the nut, resulting from the tapping of the trees. The odds for the one-, two-, and four-year periods being respectively 10,000 to 1; 191 to 1; and 10,000 to 1.

By computation it is found that 27.40 grams of oil per nut are lost as a result of tapping for the one-year period of rest (lot B); 25 grams of oil for the two-year period of rest (lot C); and 46.5 grams of oil for the four-year period of rest (lot D), using the figures from untapped nuts (lot A) as the basis. Using the same figures for the amount of harvestable nuts on a hectare of coconut plantation in a year, the loss caused by tapping the trees is 167,688 grams of oil for lot B; 153,000 grams of oil for lot C; and 248,580 grams of oil for lot D, using the figures for lot A (untapped) as the standard. For every ton of copra milled, therefore, there is a loss of 14.32 kilograms of oil from lot B; 14.94 kilograms of oil from lot C; and 25.79 kilograms of oil from lot D, when the copra that is milled is obtained from trees which had been tapped. These figures show the injurious effect of tapping the palms on the production of oil. Assuming an increase in the amount of harvestable nuts from the plantation as a result of tapping because of the stimulative effect of the operation the above figures might be reduced or totally counterbalanced. In the absence, however, of any available data any such conclusion is purely speculative.

Suitability of the oil for cooking

The four samples of oil obtained from the four lots of nuts used in this study and a sample of Purico fat were used for the determination of the suitability of coconut oil for cooking. The samples of Purico and the oil obtained from nuts of untapped trees were used as standard for the test. The object of the test was to find out whether or not there is any difference between oil obtained from nuts of trees which had been tapped and those from nuts of untapped palms for culinary purposes.

Comment is made in the paper by Jack and Dennet, on the observation of the Malayans that the suitability for culinary purposes of the oil obtained from nuts of trees which had been tapped was superior to that from nuts of untapped trees. It was also found in the present investigation that oil obtained from nuts gathered from trees which had been tapped makes a sweeter smelling oil for cooking than either the Purico or the oil obtained from untapped trees. There is practically no difference in the boiling point of the oils. It was observed that fish fried in coconut oil is firmer in texture than that fried in Purico. Hence, it may be said that oil obtained from nuts of tapped trees is superior to that obtained from nuts of untapped trees.

The study of the composition of the oil samples has not been completed; hence no explanation from a purely chemical standpoint can be advanced as to the behavior of the oils.

COLLEGE AND ALUMNI NOTES

An infirmary to accommodate the students, faculty, and employees of the University at Los Baños will soon be erected near the New Armory Building of the College of Agriculture. An appropriation of ₱18,000 has recently been voted for this purpose by the Board of Regents, and plans have been drawn up and materials for construction ordered.

An item in *Science* states, "The Baker collection of 300,000 insects received during the past year in the United States National Museum is so valuable to entomologists that Congress has been asked to appropriate $1,000 for its proper storage." This has reference to the collection of Philippine and Malayan insects which was built up by our late Dean C. F. Baker and willed to the National Museum.

Twenty-four hour electric service has recently been inaugurated on the College Campus. The current is supplied from the hydro-electric plant which is operated by the Bureau of Public Works at Los Baños.

A powerful radio receiving set, equipped with loud speaker, has been purchased by the Student Body with the financial assistance of the Molawin Hall. The apparatus has been donated to the College and installed in the Molawin Hall.

Dean and Mrs. B. M. Gonzalez were guests of honor at a dance given by the Pampangan Circle on August 17 at the Club Filipino in Manila. The Pampangan Circle is composed of students in the associated colleges of the University at Los Baños.

At the forty-sixth scientific meeting of the Los Baños Biological Club on August 22, two delegates from the University of the Philippines to the Fourth Pacific Science Congress which was held in Java last summer read papers as follows:

Dr. L. B. Uichanco. Certain phases of agricultural work in Java.
Dr. R. L. Pendleton. Some observations from travels in Java.

On August 24, the Mimics, a dramatic club of the College under the direction of Miss Anne F. Cole, gave its first production of the season in a double bill at the College Auditorium. The plays presented were Philip Hubbard's "Crumbs that Fall" and Edmond Rostand's "The Romancers."

The Soil Tillers, a local society of Visayan students, held its annual literary program and ball on August 24 in the Los Baños Y. M. C. A., with Representative José C. Locsin as guest of honor.

José M. Capinpin, '20, instructor in agronomy of this College, who is now Philippine Government pensionado in the United States, received the degree of master of arts from Princeton University last June. Mr. Capinpin was the only Filipino in the long list of 1929 Princeton graduates.

Mr. Mariano E. Gutierrez, an alumnus of this College, who is now connected with the Compañía Tabacalera, was a recent Campus visitor. Mr. Gutierrez is engaged in growing wrapper tobacco. He gave an interesting account to the members of the Agronomy Seminar of their production of wrapper tobacco in the Cagayan Valley by employing Chinese and Javanese coolies and using Sumatra methods.

Mr. Tei Ishii, assistant imperial entomologist of the Japanese Agricultural Experiment Station, returned to the College campus on August 21, after a three months' trip to Japan. While in Japan, he liberated five species of parasites of *Chilo simplex* Butler, a rice borer, which he had collected in large quantities and studied during several months' residence in Los Baños. On this visit, he expects to stay five months at the College and collect more parasites.

Letters received from Prof. Emma S. Yule speak of the cordial reception she received during her visit in Siam last June from the Siamese former students of this College. She writes in part to Dean Gonzalez:

> Mr. Purnariksha, Mr. Sindhuravejña, and Luang Inkasrikasi-karn (Iang) met me at the station. You may be sure the sight of their faces was welcome. Luang Inka is—well, not stout, but on the way. Mr. Purnariksha is several pounds heavier than when he left the College. But Mr. Sindhuravejña shows his long siege with malaria before he was transferred to Bangkok. Mr. Resananda and Mr. Sundarasinha, both of whom are in the Agricultural Teachers' Training School several hours by train from Bangkok, came in a week-end to see me. I appreciated this more than I can say. Mr. Resananda looks like an alderman; I would hardly have recognized him.
>
> I must add that our graduates here seem to be doing well, which is gratifying. They are not all in lines in which they were specially trained. I think Prince Dhani is facing a condition and cannot follow theory. This condition is shortage in teachers. Luan Inka and Mr. Purnariksha are both in one of the large secondary schools in Bangkok. Mr. Suebsaeng is in the Ministry of Agriculture and Lands. He told me his work just now had to do with plant pathology. Mr. Sindhuravejña is in the textbook bureau under the Ministry of Education.

Miss Yule is at present touring Egypt and Jerusalem. She is expecting by October to be in southern California, where she intends to spend the rest of her sabbatical leave before she returns to this College.

A MESSAGE FROM THE PRESIDENT
UNIVERSITY OF THE PHILIPPINES

A MESSAGE FROM THE PRESIDENT, UNIVERSITY OF THE PHILIPPINES

We have all reason to rejoice on this, the twentieth anniversary of the College of Agriculture. Twenty years are, after all, but a very brief span in the life of any educational institution, therefore it may be said that it is still in the stage of infancy, but judging by its record so far attained, one cannot help but envision for it unlimited possibilities for growth and service.

From humble beginnings, the College of Agriculture has risen to its present enviable proportions. It was not a mushroom growth, but the result of a dogged determination to advance gradually and steadily, under resolute and ambitious leadership. There was a time when the present site of the College was a veritable wilderness. The faculty was small, the student body but a handful. Today, it is a thriving world, with all the pulsating evidences of progress. The activities of earlier years have multiplied a thousand times. As one drives through the campus, beautiful concrete buildings on all sides, which house the various departments of the College, greet the eye; one becomes conscious of pleasant surroundings—a well-planned and well-proportioned arrangement, with good roads and bridges. Verily, the location now, with all its natural background, is a perennial joy to the eye. There is a hardy, eager and enthusiastic student body receiving daily instruction in all the various phases of College life under the guidance and inspiration of an efficient and active faculty. More than all these material changes, there arises in the minds of all those who have followed the progress of the College of Agriculture since its establishment, a realization that from this branch of the University, the country can expect much, and it is no exaggeration to say that the prosperity of the future will greatly depend on the way this College helps in the solution of our many national problems. Here is certainly an investment that is yielding invaluable returns to the country!

On this twentieth anniversary of the College, it seems appropriate to recall those men who through sacrificial labor and disinterested service have assured the future of the College. They were pioneers in their line, men who, having thrown in their lot with the College, put their heart and soul in its work. They were builders and toilers. Dean Copeland and Dean Baker, Doctor Roxas and a score of other Filipinos who are no longer in the service, deserve our most sincere gratitude because they contributed the best of their energies toward making this College one of the best in the world.

THE PHILIPPINE AGRICULTURIST, VOL. XVIII, NO. 5, OCTOBER, 1929.

The College of Agriculture has a special mission to fulfill in our educational scheme. Its inauguration was prompted by the hope that the Filipino people would learn how to apply the varied scientific knowledge of modern civilization to the extensive and intensive cultivation of the soil, and to the exploitation of the abundant agricultural resources of the country.

The prosperity of the nation has to come from the love of the people for agriculture and the guidance they receive toward taking advantage of its possibilities. The rôle of the College of Agriculture is well-defined in the program which the country has mapped out for its economic emancipation. The duty of the College lies not only in conserving and preserving, but also in revolutionizing old methods, in order that the soil, through scientific research, may yield the maximum production at a minimum cost.

We are living in a world different from that which our ancestors knew. Our economic system has met with great change. We can no longer solve our problems with the thought processes of the past. We must modify our thoughts, our methods of action and our perspective, making them consonant with the progress ushered in by the new regime, in order to discharge effectively our obligations. The College of Agriculture has this much obligation to bear—to hasten the development of the country through up-to-date scientific research and discoveries, through modern devices and through progressive approach to our numerous problems.

On this twentieth anniversary, I wish to congratulate the administration, the faculty and the student body of the College of Agriculture for their exceptional record of service and to express the hope that the coming years will see even more marked development and progress.

RAFAEL PALMA
President, University of the Philippines.

HISTORICAL

THE FIRST TWENTY YEARS OF THE COLLEGE OF AGRICULTURE

THE COLLEGE OF VETERINARY SCIENCE

THE FOREST SCHOOL

THE FIRST TWENTY YEARS OF THE COLLEGE OF AGRICULTURE

B. M. GONZALEZ
Dean, College of Agriculture

OLD COLLEGE BUILDING
The first building erected on Campus

ORGANIZATION

Act No. 1870 founding the University of the Philippines was passed on June 18, 1908. At the first meeting of the newly created Board of Regents, called on March 6, 1909, by the Honorable Newton W. Gilbert, Secretary of Public Instruction, it was unanimously decided to undertake the immediate establishment of a school of fine arts and a college of agriculture. On June 14, 1909, simultaneously with the School of Fine Arts, the College of Agriculture opened its doors as the first college organized under the University of the Philippines. The forerunners of two other colleges—Medicine and Law—existed before this time, but their incorporation into the University took place about a year and a half later.

The following students enrolled the first day:

Name	*Province*
Silvestre Asunción	Batangas
Amando Laparan	Batangas
Baldomero Velasquez	Rizal
Antonio Lejano	Batangas
Florencio Bagui	Batangas
Felipe O. Cevallos	Albay
Andrés F. Navarro	Albay

Vicente F. Allarey	Tayabas
Eladio Sablan	Laguna
Valente E. Villegas	Laguna
José F. Zamora	Manila
Clodoaldo Tempongko	Manila

The enrollment was 56 the first year. Since then there has been a more or less steady increase, as may be seen in the following figures:

Year	*Number*	*Year*	*Number*
1909	56	1920	528
1910	95	1921	622
1911	175	1922	637
1912	253	1923	648
1913	294	1924	575
1914	380	1925	606
1915	428	1926	702
1916	450	1927	789
1917	564	1928	881
1918	366[a]	1929	749[b]
1919	462		

[a] Requirement for admission to six-year course raised to two years high school for this year only.

[b] As of June 30, 1929. Admission of new students to six-year course closed beginning this year.

At first the members of the faculty met their students in their homes in Los Baños proper, then in tents pitched at Camp Eldridge. The students walked to the farm in the afternoons for their field work. In the meantime a building of mixed materials, now housing the English Department and the Post Office, was being erected on the Campus. Upon its completion on October 5, 1909, all sessions were held on the Campus.

Even before the organization of the University, the founding of an "insular agricultural school" was already seriously considered by the Bureau of Education. As early as 1907, Dr. E. B. Copeland, then instructor in botany at the Philippine Normal School, was commissioned to select a suitable site. After considering a number of possible locations, he reported as follows:

Manila, August 9, 1907.

The Acting Director of Education,
Manila.

Sir:

During the past two months I have visited every site in the Islands which there was any reason for supposing might be chosen for the insular agricultural school. These sites have been in the provinces of Rizal, Nueva Ecija, Cavite, Negros Occidental and La Laguna. My conclusions are herewith submitted.

The first consideration in judging a site for an insular school is that it furnish an opportunity for the students to become acquainted, under favorable conditions, with all the important Philippine products. Of the places visited in Rizal, Nueva Ecija and Cavite, none meet this demand. The places visited which can satisfy it are:—

1. The Granja Modelo, near La Carlota, Negros Occidental. This does not at present include land of every desired condition, but can be made to do so by including a strip of land from San Miguel to the summit of Canlaon, as recommended in my special report on that site.
2. The land east of Lake Calibato, in the barrio of Rizal, Nagcarlan, La Laguna.
3. The barrio of Gagalit, Majayjay, La Laguna.
4. A site to be reached by going about 2 kilometers out the Bay road from Los Baños, and then about the same distance to the right at a right angle to the road.

It is the contiguity of a large mountain which gives each of these sites its favorable climate, and at the same time offers a place where the characteristic upland crops can be grown. A limited amount of water for irrigation is available at each of these places; Gagalit is the only one where all that could well be used is available by gravity alone. At any one of these four sites a forestry school can be located advantageously. At La Granja the land is available without expense; and I presume that the province of La Laguna would gladly furnish any one of the three eligible sites within its boundaries. The smallest area which ought to be considered is 100 hectares of even, tillable land, in the farm proper, aside from forest and upland.

Given land enough, suitable to the requisite variety of crops, the next consideration is accessibility. In this respect, Los Baños is by far the best of these places; Lake Calibato is next; and Gagalit is in some respects as inaccessible as La Granja. Accessibility is important in two chief ways:—as a factor in the cost of construction and furnishing supplies; and as a factor in determining the attendance. Construction at Gagalit might be even more expensive than at La Granja; but a student could reach it in one day from Manila, and the attendance would be much greater. Accessibility to Manila has the further obvious advantage that it will permit constant easy communication between the school and the central offices of the Bureaus of Education, Science, and Agriculture.

For the school as a purely educational institution, the best site I have seen is Gagalit; but it is a poor place for an insular experiment station, because of its exceptional coolness. For an experimental station, purely as a place of research, La Granja has the greatest *natural* advantages; but for a school, it is the least desirable place under consideration, because it will surely attract the fewest students. Considering both demands on the site, I can without hesitation recommend that near Los Baños as the best, with Lake Calibato as second.

Very respectfully submitted,
E. B. COPELAND.

Final selection rested on Los Baños and a site located in the barrio of Batong Malaki containing 72.63 hectares, on which the Bureau of Education held an option, was purchased by the Board of Regents of the University of the Philippines from Agripino Salva Cruz, Felipe Belarmino, Victor Alviar, Pedro de Luna, and others. This property became the site of the College of Agriculture.

Since then several additions have been made to the College property as may be seen in the list below:

Year	Former Owners	Area in hectares
1909	Original purchase from various owners	72.6296
1913	Nicasio Villegas	22.5225
1914	Mauro Prieto	32.3822
1917	E. B. Copeland	6.4200
1918	Expropriated from various owners for:	
	(*a*) Agronomy experimental fields	139.7385
	(*b*) Animal Husbandry pasture lands	122.0320
1929	From various owners for Los Baños Limnological Station	1.4371
	Total	397.1619

The total area of the College lands at this date amounts to 397.1619 hectares. All lands are contiguous and at the foot of Mt. Maquiling, except that for the Limnological Station, which is on the shore of Laguna de Bay.

In the words of Dean Copeland, "The land is diversified and permits the cultivation of every important crop of the Philippines."

From time to time after its foundation doubts were expressed as to the wisdom of having located the College where it is. The chief objection to the present site was its relative inaccessibility and isolation from the rest of the University. So long as these doubts existed, plans for development were continually delayed. On October 21, 1915, Dean Copeland wrote a vigorous memorandum setting forth the reasons why Los Baños was chosen as the permanent site for the College of Agriculture, and recommended a definite decision on this point. After this all such questions were laid to rest, and the College was no longer hampered by indecision on this account.

The College is 68 kilometers from Manila and can now be reached by rail and by motor car on a first class road. The trip takes from one and a half to two hours.

THE CURRICULA OF THE COLLEGE

From the beginning the College admitted two classes of students, those having been graduated from the intermediate school and those from the high school. In view of the scarcity of high school graduates when the College was first organized, the major portion of the students were of the first class and followed this curriculum:

The Six-year Course of Study in Agriculture

FIRST YEAR	SECOND YEAR	THIRD YEAR
English I	English II	Chemistry I
Mathematics I	Mathematics II	Mathematics III
German I	German II	Zoology I
Botany I	Botany II	Agronomy I

FOURTH YEAR	FIFTH YEAR	SIXTH YEAR
Chemistry II	Elective*	Elective*
Farm Engineering	Physics	Elective*
Zoology II	Animal Husbandry	Elective*
Agronomy II	Agronomy III	Agronomy IV (Thesis)

*"There are offered as electives two additional years in chemistry, one each in farm engineering, animal husbandry, and botany, two years in Spanish, and any of the courses described in the general course in forestry."

Students graduating in these courses were given the degree of Bachelor of Agriculture. In the beginning, there was no set curriculum for high school graduates. They were given the same curriculum with advanced credit in the courses equivalent to subjects taken in the high school, so that it took them four years, instead of six, to finish the course. They were granted the degree of Bachelor of Science in Agriculture upon graduation.

In 1910 a formal curriculum was formulated as follows:

The Four-year Course

FIRST YEAR	SECOND YEAR	THIRD YEAR	FOURTH YEAR
Botany II	Agronomy I	Agronomy II	Agronomy IV or V
German I	German II	Rural Engin. I	Elective
Chemistry I	Chemistry II	Agronomy III	Elective
Zoology I	Zoology II	Animal Husb. I	Thesis

The growth of enrollment in the four-year course has been very steady, although slow in the beginning. The proportion of these students to the six-year course students in the entering class has increased from 1 to 10 in 1909 to 1 to 7.4 in 1919, and to 1 to 1.9 in 1928, the last year new students were admitted to the six-year course.

From the beginning a thesis representing at least a year's work in one subject was required in the senior year in both courses. At first most theses were in agronomy, but later other subjects were represented more and more.

This curriculum suffered little modification until April 1, 1917, when the two years of German were replaced by agricultural economics, farm accounting, farm practice, blacksmithing, and carpentry. With the growth of the College and the development of other departments, minor changes took place. Instruction in plant pathology began in 1916 and later in the same year military science was added.

In 1921 two specialized curricula were organized, the Animal Husbandry Curriculum, open to intermediate and high school graduates, and the Sugar Technology Curriculum, open to high school graduates only. In 1925 a combined Animal Husbandry-Veterinary Science Curriculum for high school graduates was also offered.

The most radical change in the college curriculum took effect on April 1, 1929, when the doors of the institution were closed to intermediate school graduates.

Simultaneously with this event a new curriculum was drawn which aims to give the student during the first two and a half years of his course a broad basic training in the sciences fundamental to agriculture, as well as in agricultural subjects of general application. The last year and a half is devoted almost entirely to training along a specialized agricultural subject elected by the student. This new curriculum is a natural development of the specialized courses organized in 1921, which have given such satisfactory results, and aims to extend the benefits of specialization, now so keenly felt in all lines of human endeavor, to other subjects represented by departments in the College.

The present curriculum follows:

The College of Agriculture General Course

FIRST YEAR

First Semester	*Hours*	*Units*	*Second Semester*	*Hours*	*Units*
Math. 1	3	3	Entom. 1	9	5
Agron. 1	6	2	Agron. 1	6	2
Agron. 2	5	5	A. Husb. 1	3	3
R. Econ. 1	2	2	R. Econ. 1	2	2
A. Chem. 1	9	5	A. Chem. 1	9	5
Zool. 1	9	5	Physics 1	7	5
		22			22

SUMMER

Farm Experience: A—Summer Farm Practice
B—Blacksmithing or
H—Household Engineering
C—Carpentry

SECOND YEAR

A. Chem. 2	9	5	P. Path. 1	9	5
A. Husb. 2	6	2	A. Husb. 2	6	2
P. Physl. 1	9	5	P. Physl. 1	9	5
Agron. 3	9	5	Agron. 5	5	5
English 1	5	5	English 1	5	5
		22			22

THIRD YEAR

A. Engin. 1	5	3	A. Engin. 2	5	3
P. Physl. 2 or)	(9)	(5)	A. Engin. 3	5	3
A. Chem. 3...)	9	5	R. Econ. 2	3	3
R. Econ. 2	3	3	Presc'd Elect*		5
Presc'd Elect*		5	Major		5
Major		3			19
		19			

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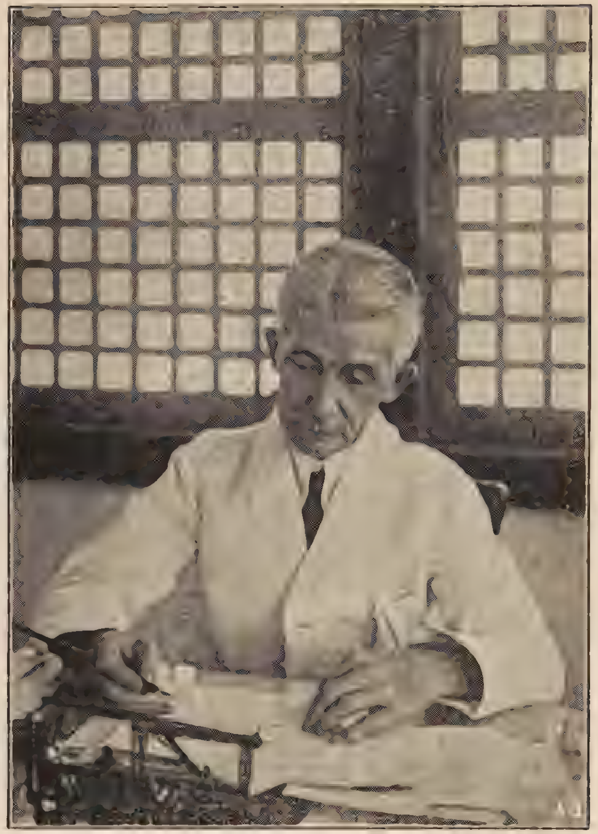
*To be prescribed by the head of the department under whom the student is majoring.

EDWIN BINGHAM COPELAND
Dean, June 14, 1909—August 30, 1917



CHARLES FULLER BAKER
Dean, September 27, 1917—July 22, 1927

FOURTH YEAR

Major	11	Major	11
Presc'd Elect.*	3	Presc'd Elect.*	3
Free Elect.	5	Free Elect.	5
	19		19

*To be prescribed by the head of the department under whom the student is majoring

At the same time graduates from the intermediate school were refused admission to the College proper, a Rural High School was opened. This was in June, 1929. This will serve as a training school for students specializing in agricultural education. The creation of the Department of Agricultural Education was made possible through the inclusion of the College of Agriculture in the provisions of the Vocational Education Act, No. 3377, charging it with the duty of training teachers for lower agricultural schools. The new department offered its first courses in October, 1928.

THE FACULTY

The faculty of the College during the first year consisted of the following:

Edwin Bingham Copeland, Ph. D.	Dean and Superintendent.
Harold Cuzner, B.S.F.	Farm Superintendent.
Edgar Madison Ledyard	Instructor in Zoology, Secretary of the Faculty.
Carrie Stein Ledyard	Instructor in Modern Languages.
Sam B. Durham, B.S.	Instructor in Animal Husbandry.

The above faculty carried the whole curriculum in the beginning. Since then there have been constant additions to and replacements in the faculty so that at this time there are about 100 members on the teaching staff, including 40 graduate assistants.

The administration of the College was placed in the hands of its founder, Dr. E. B. Copeland, who held the position of dean from June 14, 1909, to August 30, 1917. During his incumbency a number of members of the faculty acted as dean when Doctor Copeland was on leave, including Prof. E. M. Ledyard, Dr. F. W. Foxworthy, and Dr. H. G. Deming. Upon the resignation of Doctor Copeland, President Ignacio Villamor of the University become acting dean until the appointment of Professor C. F. Baker to the position, which he held from September 27, 1917, to his death on July 22, 1927. During Dean Baker's incumbency, and in his absence, Dr. M. L. Roxas and Prof. E. D. Hester acted in this capacity. Upon Dean Baker's demise, Acting President Jorge Bocobo served as dean, until the appointment of the writer as acting dean on August 27, 1927, and as permanent dean on October 24, 1928.

The part played by Dean Copeland and Dean Baker in the organization and development of the College has been described elsewhere[1].

[1] Gonzalez, B. M. 1927. In retrospect. The Philippine Agriculturist **16**: 121-124.

The College has a peculiar problem in the replenishment of its faculty ranks. There being no other agricultural institution of collegiate rank in the country, it cannot recruit them locally except from its own graduates. And there are no other well-developed colleges of agriculture in the tropics. It is also obvious that it would neither be wise, nor possible, economically or otherwise, to continually draft its faculty from temperate countries where agricultural conditions are very different. Furthermore, it has been our experience that men secured from abroad do not usually remain long in this country. The average term of such men has been about three years. In other words, they depart about the time they have become fairly well acquainted with local conditions and problems. In view of the difficulties pointed out above, a system of developing faculty members has been evolved which is working satisfactorily. The most promising members of the student body are trained and coached in their chosen specialties beginning in their undergraduate years. They are then taken into the faculty as junior members or assistants, and their training is continued. After they have absorbed all they can locally, those that have stood the test are sent abroad on fellowships, to American universities usually, for their higher degrees. After an intensive period of specialized training and travel, which usually includes Europe and Oriental countries en route, they are taken in as full-fledged members of the faculty. The present faculty consists of fully 90 per cent of such men. In training and accomplishments it will compare favorably with any similar faculty.

FACULTY OF THE COLLEGE OF AGRICULTURE

1929-1930

PROFESSORS

BIENVENIDO M. GONZALEZ, Sc. D.

Dean, Director of the Agricultural Experiment Station, Head of Department and Professor of Animal Husbandry

B. Agr., University of the Philippines, 1913; M. S., University of Wisconsin, 1915; Sc. D. in Hygiene, Johns Hopkins University, 1923; University of the Philippines fellow at University of Wisconsin, 1914-1916, and at Johns Hopkins University, 1921-1922; Member, Board of Regents, University of the Philippines, 1918-1921; Assistant, Instructor, Assistant Professor, and Associate Professor of Animal Husbandry, University of the Philippines, 1913-1920.

INOCENCIO ELAYDA, M.S.A.

Director of Extension Service

B.S.A., Iowa State College, 1911; M.S.A., University of the Philippines, 1915; Assistant in Mathematics, 1911; Farm Foreman, 1912; Instructor in Agronomy and Farm Foreman, 1913; Assistant Professor, Associate Professor, and Professor of Agronomy, 1917-1920; Professor of Farm Management, 1920; Director of Extension Work of the College of Agriculture, 1922-1924; Assistant Director of Agriculture, 1924; reinstated as Director of Extension Service, 1924.

RAFAEL B. ESPINO, Ph. D.

Head of Department and Professor of Plant Physiology

B. Agr., University of the Philippines, 1915; Ph. D., Johns Hopkins University, 1919; University of the Philippines fellow at Johns Hopkins University, 1917-1919; Assistant in Botany, 1915-1917; Instructor in Agronomy, and Assistant Professor of Agronomy, 1919-1920; Assistant Professor, and Associate Professor of Plant Physiology, University of the Philippines, 1920-1929.

MERLE A. FOSTER, M.S.

Head of Department and Professor of Agricultural Education

B. Di., Highland Park College, 1915, and A. B., 1916; A. B., Des Moines University, 1922; M. S., Iowa State College, 1923; Principal, American Institute Commercial School, La Paz, Bolivia, 1917-1918; Superintendent, Havelock (Iowa) Consolidated Schools, 1919-1920; Auditor and Acting Principal, Central Luzon Agricultural School, 1921-1923, Principal Statistical Assistant, United States Bureau of Education, 1923-1928.

REGINALD H. KING, M.S.

Professor of Sugar Technology

B. S., University of California, 1921; M. S., University of Hawaii, 1927; Assistant Chief Chemist, Western Sugar Refining, San Francisco, California, 1918-1923; Assistant Chemist, Sugar Technology Department, Hawaiian Sugar Planters' Association, 1923-1928.

NEMESIO B. MENDIOLA, Ph. D.

Head of Department and Professor of Agronomy

B.S.A., University of the Philippines, 1914, and M.S., 1916; Ph. D. Cornell University, 1918; University of the Philippines fellow at Cornell University, 1916-1918; Consulting Plant Breeder, Bureau of Agriculture, 1919-1929; International Education Board of New York fellow in agriculture in Java, 1926-1927; Assistant, Instructor, Assistant Professor, and Associate Professor of Agronomy, University of the Philippines, 1918-1929.

ROBERT L. PENDLETON, Ph. D.

Professor of Soil Technology

B.S., University of California, 1914, and Ph. D., 1917; University fellow in Soil Chemistry, 1916-1917; Assistant in Soil Survey, California Agricultural Experiment Station, 1914-1915; Assistant Director of Agriculture, Gwalior State, Central India, 1918-1920; and Acting Director, 1919-1920; Director of Agriculture, Gwalior State, Central India, 1920-1923.

LEOPOLDO B. UICHANCO, Sc. D.

Head of Department and Professor of Entomology

B.S.A., University of the Philippines, 1915, and M.S., 1918; M.S. in Zoology, Harvard University, 1920, and Sc. D., 1922; University of the Philippines fellow at Harvard University, 1919-1922; Assistant, Instructor, Assistant Professor, and Associate Professor of Entomology, University of the Philippines, 1915-1929.

EMMA S. YULE, B. Di.

Head of Department and Professor of English

B. Di., Iowa State Teachers' College, 1886; Instructor in English, Bureau of Education, 1914-1915; Instructor, Assistant Professor, and Associate Professor of English, University of the Philippines, 1916-1929; on sabbatical leave.

ASSOCIATE PROFESSORS

VICENTE G. LAVA, Ph. D.

Associate Professor of Agricultural Chemistry

B.S., University of the Philippines, 1916; M.A., Columbia University, 1920, and Ph. D., 1923; Physical Chemist, Bureau of Science, Manila, 1923-1925.

FRANCISCO O. SANTOS, Ph. D.

Acting Head of Department and Associate Professor of Agricultural Chemistry

A.B., University of the Philippines, 1914, and M.S., 1919; Ph. D., Yale University, 1922; Assistant and Instructor in Mathematics, University of the Philippines, 1915-1919; University of the Philippines fellow at Yale University, 1919-1922; Biochemist, Department of Pediatrics, Bellevue Hospital, New York, 1922; Assistant Professor of Agricultural Chemistry, University of the Philippines, 1922-1925; Consulting Biochemist Office of the Public Welfare Commissioner, 1928.

ASSISTANT PROFESSORS

FELIPE T. ADRIANO, Ph. D.

Assistant Professor of Agricultural Chemistry

B. Agr., University of the Philippines, 1919; M. S. in Chemistry, University of Wisconsin, 1920; Ph. D., Cornell University, 1927; Consulting Chemist and Representative of the Laguna-Batangas Sugar Planters at the Calamba Sugar Estate, Canlubang, Laguna, 1921; Analyst, University of the Philippines, 1922-1923; University of the Philippines fellow at Cornell University, 1925-1927.

ESTHER A. ANDERSON, A.B.

Assistant Professor of English

A.B., University of California, 1921; Instructor, Garden Grove Grammar School, 1921-1924; Principal, Garden Grove Grammar School, 1923-1924; Instructor in English, Julia C. Lanthrop Junior High School, Santa Ana, California, 1924-1925; Instructor in English, San Pedro High School, Los Angeles School System, California, 1925-1927; Instructor in English, University of the Philippines, 1927-1929.

FELIPE O. CEVALLOS, Ph. D.

Teacher on detail by Bureau of Education at Department of Agricultural Education

B. Agr., University of the Philippines, 1912; M.S., University of Wisconsin, 1921, and Ph. D., 1923; Principal, Guinobatan Rural High School, 1912-1919; Bureau of Education Pensionado at University of Wisconsin, 1920-1923; Teacher, Central Luzon Agricultural High School, 1923-1924; Principal, Catarman Agricultural High School, 1924-1927; Principal, Pampanga Agricultural High School, 1927-1928; Supervisor of Agriculture, Bureau of Education, 1928-1929.

HELEN FOSTER, A.B.

Assistant Professor of Agricultural Education

B. Di., Des Moines College, 1916, and A.B., 1917; American Institute, La Paz, Bolivia, 1917-1918; American Institute, Iquique, Chile, 1918; Lineville, Iowa, 1918; Teacher, Central Luzon Agricultural School, 1921-1923; American Institute (Commercial College, Des Moines, Iowa) 1926-1927.

SIXTO A. FRANCISCO, M.D.

College Physician

M.D., University of Illinois, 1917; Intern, Battle Creek Sanitarium and Hospital, Michigan, 1918; Resident Physician, Baguio Hospital, 1919; Lecturer in Physiology, Hygiene and Sanitation, College of Agriculture, University of the Philippines, 1920-1921, and 1928-1929.

FRANCISCO M. FRONDA, PH. D.

Assistant Professor of Poultry Husbandry
and Acting Secretary of College

B. Agr., University of the Philippines, 1919; M. S., Cornell University, 1920, and Ph. D., 1922; Assistant in Animal Husbandry, 1919-1922; University of the Philippines pensionado at Cornell University, 1919-1922; Instructor in Poultry Husbandry, University of the Philippines, 1922-1926.

LEON G. GONZALEZ, PH. D.

Assistant Professor of Agronomy

A. B., University of the Philippines, 1920; B.S.A., 1922, and M.S., 1923; Ph. D., Cornell University, 1927. University of the Philippines fellow at Cornell University 1924-1927; Assistant in Mathematics, University of the Philippines, 1920-1921; Assistant, and Instructor in Agronomy, University of the Philippines, 1921-1928.

ALEXANDER GORDON, PH. D.

Assistant Professor of Agricultural Engineering

B. Agr., University of the Philippines, 1923, and B.S.A., 1924; M.S.A., Cornell University, 1925, and Ph. D., 1927; Philippine Government pensionado at Cornell University and at Colorado State Agricultural College, 1924-1927; Assistant, and Instructor in Agricultural Engineering, University of the Philippines, 1923-1928.

CAROLINE VIRGINIA LEE, L.I.

Assistant Professor of English

L.I., University of Nashville, Peabody Normal College, Nashville, Tennessee, 1897; Instructor in Bible, English, History and Geography, James Sprunt Academy, Kiangyin, China, 1917-1927; Instructor in English, University of the Philippines, 1927-1929.

MARIANO C. LOPEZ, M.A.

Assistant Professor of Rural Economics

B.S.F.S. and M.A., Georgetown University; Secretary, College of Agriculture, 1925-1927; on leave.

MIGUEL MANRESA, PH. D.

Assistant Professor of Animal Husbandry

D.V.M., University of the Philippines, 1921; Ph. D., University of Wisconsin, 1928; Assistant in Clinical Diagnostics, Instructor in Veterinary Anatomy, Instructor in Veterinary Medicine, University of the Philippines, 1920-1925; University of the Philippines fellow at the University of Wisconsin, 1925-1928; Instructor in Animal Husbandry, University of the Philippines, 1928-1929.

MARIANO MONDOÑEDO, D.V.M.

Assistant Professor of Animal Husbandry

B.S.A., Iowa State College of Agriculture and Mechanic Arts, 1920; D.V.M., University of the Philippines, 1926; Principal, Indang Farm School, 1915-1920; Instructor in Animal Husbandry, 1920-1927.

GERARDO O. OCFEMIA, PH. D.

Assistant Professor and Acting Head, Department of Plant Pathology

B. Agr., University of the Philippines, 1915, and M.S.A., 1920; Ph. D., University of Wisconsin, 1923; University of the Philippines fellow at the University of Wisconsin, 1920-1923; Assistant in Agronomy, 1915-1917; Assistant in Botany, 1917-1918; Assistant and Instructor in Plant Pathology, University of the Philippines, 1918-1924.

JOSÉ E. OLIVARES, M.S.E.E.

Assistant Professor of Military Science and Tactics, and Assistant Commandant, Los Baños U. P. Cadet Unit

Graduate, U. S. Naval Academy, 1923; M.S. in Electrical Engineering, Massachusetts Institute of Technology, 1926; and Second and First Lieutenant, C.A., P.S., U. S. Army, 1922-   ; Graduate, Coast Artillery School, Battery Officers' Course, 1925.

MANUEL A. ROA, B.S.

Assistant Professor of Physics and In Charge of Mathematics

B.A. and B.S., University of the Philippines, 1919; Instructor in Mathematics, University of the Philippines, 1919-1929.

EDWIN E. SCHNEIDER, B.L.

Assistant Professor of Modern Languages

B.L., University of Cincinnati, 1897; Teacher of Languages, various public and private schools, U.S.A., 1895-1900; Teacher, Philippine Bureau of Education, 1901-1908; Wood Expert, Philippine Bureau of Forestry, 1908-1921; Instructor in Wood Technology, School of Forestry, 1910-1912; farmer, 1921-1929.

ANASTASIO L. TEODORO, PH. D.

Assistant Professor and Acting Head, Department of Agricultural Engineering

B. Agr., University of the Philippines, 1918; M.S., Cornell University, 1921, and Ph. D., 1928; farmer, Copeland Farm, Chico, California, 1918; University of the Philippines pensionado at University of Wisconsin, 1919-1921; and Cornell University, 1926-1928; Research Fellow, Iowa State College of Agriculture and Mechanic Arts, 1921; Instructor in Rural Engineering, University of the Philippines, 1921-1924; and Consulting Agricultural Engineer, Bureau of Agriculture, Manila, 1922.

DEOGRACIAS V. VILLADOLID, PH. D.

Assistant Professor of Entomology
(Agricultural Zoology)

B. Agr., University of the Philippines, 1919; B.S.A., 1923, and M.S.A., 1924; Ph. D., Leland Stanford Junior University, 1927; Assistant in Chemistry, University of the Philippines, 1919; University of the Philippines fellow at Leland Stanford Junior University, 1924-1927; Assistant, and Instructor in Entomology (Agricultural Zoology), 1919-1928.

VALENTE VILLEGAS, PH. D.

Assistant Professor of Animal Husbandry and Assistant Head of Department

B. Agr., University of the Philippines, 1913; Ph. D., Iowa State College of Agriculture and Mechanic Arts, 1921; Assistant Agricultural Inspector, Agricultural Assistant, Agricultural Inspector, Philippine Bureau of Agriculture, 1913-1917; Philippine agricultural representative at the Panama-Pacific International Exposition, 1915; Instructor in Animal Husbandry, 1917-1918; Instructor in Agronomy, 1918-1919; University of the Philippines pensionado at Iowa State College of Agriculture and Mechanic Arts and University of Illinois, 1919-1922.

INSTRUCTORS

BENEDICTO C. DE LAS ALAS, B.S.A.

Instructor in Mathematics

B. Agr., University of the Philippines, 1921, and B.S.A., 1924; Assistant in Mathematics, University of the Philippines, 1921-1926.

VICENTE B. ARAGON, B. AGR.

Instructor in Agronomy

B. Agr., University of the Philippines, 1918; Farm Adviser, 1918-1919, and Agricultural Extension Agent, Bureau of Agriculture, 1919-1924; Farm Manager, Central Luzon Agricultural School, 1924-1929.

EULALIO P. BALTAZAR, M.S.

Instructor in Agronomy

B.S.A., University of the Philippines, 1922, and M.S., 1924; Assistant in Agronomy, University of the Philippines, 1922-1925; Head Teacher in Science, La Union High School, 1925-1928.

TEODOSIO F. BUENAVENTURA, LL. B.

Instructor in History and Spanish

B.A., University of the Philippines, 1915; LL. B., University of Southern California, 1923.

JOSÉ M. CAPINPIN, M.S.

Instructor in Agronomy

B. Agr., University of the Philippines, 1920; B.S.A., 1922; and M.S., 1923; M.A., Princeton University, 1929; University of the Philippines pensionado at Princeton University, 1928- ; Assistant in Agronomy, University of the Philippines, 1920-1927. On leave.

ALEJANDRO B. CATAMBAY, M.S.

Instructor in Agronomy

B. Agr., University of the Philippines, 1924, and B.S.A., 1925; M.S., University of California, 1927; Assistant in Agronomy, University of the Philippines, 1924-1925.

SILVERIO M. CENDAÑA, B.S.A.

Instructor in Entomology

B. Agr., University of the Philippines, 1921; and B.S.A., 1923; Assistant in Entomology, University of the Philippines, 1921-1928.

ANNE F. COLE, A.B.

Instructor in English

A.B., University of North Dakota, 1922; Instructor in History, Bowbells High School, North Dakota, 1922-1923; Instructor in History, Blackfoot High School, Idaho, 1923-1924; Instructor, Jane Addams Grammar School, Long Beach, California, 1924-1928.

ESTEBAN G. COLLADO, M.S.A.

Instructor in Agricultural Chemistry

B. Agr., University of the Philippines, 1919, B.S.A., 1922, and M.S.A., 1923; Assistant in Agricultural Chemistry, University of the Philippines, 1919-1923.

PAULINO E. COSTA, B.S.

Instructor in Horticulture and Science, Department of Agricultural Education

B.S., University of California, 1923; Teacher, Pangasinan Academic High School, 1926-1927; Teacher, Indang Rural High School, 1927-1929.

RAMON A. CRUZ, B.S.A.

Instructor in Agricultural Chemistry

B. Agr., University of the Philippines, 1923, and B.S.A., 1924; Assistant in Chemistry, 1923-1926; Chemist for Malabon Sugar Company, 1926-1929.

PEDRO A. DAVID, M.S.

Instructor in Agronomy

B. Agr., University of the Philippines, 1919; B.S.A., 1922, and M.S., 1925; University of the Philippines fellow at Wisconsin University, and Iowa State College of Agriculture and Mechanic Arts, 1927- ; Assistant in Agronomy, University of the Philippines, 1919-1921. On leave.

VICENTE M. DAWIS, B.S.A.

Instructor in Agronomy

B. Agr., University of the Philippines, 1916, and B.S.A., 1922; Assistant Farm Superintendent, College of Agriculture, 1920-1922; Acting Farm Superintendent, 1922-1929; Farm Superintendent, Coconut Project, Calamba Sugar Estate, 1916-1920.

SUE DENNY, A.B.

Instructor in English

A.B., University of Texas, 1919; Instructor in English, El Paso High School, El Paso, Texas, 1919-1921; Instructor in Biology, Galveston High School, Galveston, Texas, 1921-1922; Instructor in Biology and Economics, Scoville School, New York City, 1922-1923; Instructor in Biology, Dallas High School, Dallas, Texas, 1923-1924; Principal, American School, Pachuca, Hidalgo, Mexico, 1924-1925; Instructor in Mathematics, Dallas High School, Dallas, Texas, 1925-1929.

LEANDRO S. EBRO, JR., M.S.M.E.

Instructor in Sugar Engineering

B.S.M.E., University of California, 1926, and M.S.M.E., 1927.

JOSÉ P. ESGUERRA, B.S.A.

Junior Animal Husbandman

B. Agr., University of the Philippines, 1919; and B.S.A., 1922; Assistant in Animal Husbandry, University of the Philippines, 1918-1919; Special Agent, Philippine Constabulary, 1925- .

ALEJANDRO FERRER, B.S.C.E.

Instructor in Mathematics

B.S.C.E., University of the Philippines, 1925; C.E. granted by the Philippine Board of Examiners for Civil Engineers, 1925; private civil engineer, 1925-1929.

NICOLAS L. GALVEZ, B.S.

Instructor in Agricultural Chemistry

B.S. in Chemistry, University of Minnesota, 1925; Assistant Chemist, Del Carmen Central, Pampanga, 1925-1926.

PABLO N. MABBUN, B.S.A.

Instructor in Rural Economics

B.S.A., University of the Philippines, 1923; Assistant in Rural Economics, University of the Philippines, 1923-1924; Instructor in Biology, Bureau of Education, 1924-1925.

ROBERTO R. MORENO, M.S.

Instructor in Agricultural Chemistry

B.S., Cornell University, 1925, and M.S., 1926.

ELISEO K. ONGSANSOY, B.S.M.E.
Instructor in Agricultural Engineering

B.S.M.E., University of the Philippines, 1926; Assistant Mechanical Engineer, Government Ice Plant, 1926-1927; Designer, Manila Electric Company, 1927; Teacher in Physics, Laguna Provincial High School, 1927-1929.

FERNANDO DE PERALTA, M.S.A.
Instructor in Plant Physiology

B. Agr., University of the Philippines, 1919; B.S.A., 1922, and M.S.A., 1923; Assistant in Plant Physiology, University of the Philippines, 1919-1924.

HAZEL D. REED, A.B.
Teacher in English, Department of Agricultural Education

A.B., Morningside College, 1923; Teacher, Callender, Iowa, 1919-1920; Principal and Teacher, Lehigh High School, Iowa, 1923-1929.

ANTONIO L. ROCAFORT, B.S.A.
Instructor in Physics

B. Agr., University of the Philippines, 1922, and B.S.A., 1924; Assistant in Physics, University of the Philippines, 1922-1929.

EMILIANO F. ROLDAN, M.S.A.
Instructor in Plant Pathology

B. Agr., University of the Philippines, 1919, B.S.A., 1922, and M.S.A., 1923; University of the Philippines fellow at the University of Illinois, 1927-1929; Assistant in Plant Pathology, 1919-1924.

FELIX B. SARAO, M.S.
Instructor in Animal Husbandry

B.S.A., University of the Philippines, 1917; M.S., University of Wisconsin, 1922; Agricultural Assistant, Department of Mindanao and Sulu, 1917-1920.

FLORENCIO A. SOLIVEN, M.S.A.
Instructor in Agricultural Chemistry

B. Agr., University of the Philippines, 1921, B.S.A., 1923, and M.S.A., 1924; Assistant in Agricultural Chemistry, 1922-1924.

VICTOR SULIT, M.S.A.
Instructor in Agricultural Chemistry

B. Agr., University of the Philippines, 1919, B.S.A., 1922, and M.S.A., 1923; Assistant in Agricultural Chemistry, University of the Philippines, 1919-1923. University of the Philippines fellow at University of Chicago, 1927- . On leave.

ALEJO T. TALEON, M.S.A.
Instructor in Animal Husbandry

B.S.A., University of the Philippines, 1921; and M.S.A., 1923; Assistant in Animal Husbandry, University of the Philippines, 1921-1925.

RAMON B. TOLENTINO, B.S.A.
Instructor in Physical Education and Athletic Director, U. P. Los Baños Unit

B.S.A., University of the Philippines, 1924.

JOSÉ E. VELMONTE, B.S.C.
Instructor in Rural Economics

A.B., University of the Philippines, 1920, and B.S.C., 1921; Agent, Bureau of Commerce and Industry, 1919-1922.

ASSISTANTS[1]

DIONISIO I. AQUINO, B. AGR., B.S.A., M.S.A.,
Assistant in Agronomy (Fellow on leave).

MARCELO V. ARNALDO, B.S.A.,
Assistant in Rural Economics.

JUAN D. ATIENZA, B. AGR.,
Assistant in Plant Pathology.

TOMAS BANDONG, B. AGR., B.S.A.,
Assistant in Agronomy.

FRANCISCO BARROS, B.S.A.,
Assistant in Chemistry.

EUSEBIO A. BATACLAN, B. AGR., B.S.A.,
Assistant in Sugar Technology.

PRIMO CARREON, B. AGR., B.S.A.,
Assistant in Agricultural Engineering (Fellow on leave).

MARTIN S. CELINO, B.S.A.,
Assistant in Plant Pathology.

ARSENIO Y. CORONEL, B. AGR.,
Assistant in Entomology.

ROMAN P. ESTIOKO, B. AGR., B.S.A.,
Assistant in Plant Physiology.

GETULIO A. GUANZON, B.S. AGR. (With Certificate in Sugar Technology).
Assistant in Sugar Technology (Fellow on leave).

ATANACIO S. HIZON, B.S.S.T.,
Assistant in Chemistry.

JOSÉ B. JULIANO, B.S.A., M.S.A.,
Assistant in Plant Physiology (Fellow on leave).

MOISES M. KALAW, B. AGR., B.S.A.,
Assistant in Extension Service.

HONORATO E. LUMANG, B. AGR.,
Assistant in Chemistry.

MAMERTA MANAHAN, PHAR. CHEM.,
Assistant in Chemistry.

ANDRÉS M. MANE, B. AGR.,
Assistant in Zoology.

CANUTO G. MANUEL, B. AGR., B.S.A.,
Assistant in Zoology (On leave).

ARCADIO G. MATELA, B. AGR.,
Assistant in Agronomy.

TORIBIO MERCADO, B. AGR.,
Assistant in Agronomy.

TEOFILO F. NOVERO, B. AGR., B.S.A.,
Assistant in Agronomy.

PEDRO S. PAJE, B. AGR.,
Assistant in Animal Husbandry.

FELICIANO PANTALEON, B. AGR.,
Assistant in Plant Physiology.

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[1] Graduates of the University of the Philippines.

NAZARIO PIDLAOAN, B. Agr.,
Assistant in Chemistry.

JUAN R. PRONTO, B. Agr., B.S.A.,
Assistant in Chemistry.

JOSÉ C. RAMOS, B. Agr., B.S.A.,
Assistant in Agronomy.

FERNANDO REYES, B. Agr.,
Assistant in Agronomy.

RAFAEL B. ROTOR, B. Agr.,
Assistant in Rural Economics.

FRANCISCO M. SACAY, B. Agr., B.S.A.,
Assistant in Rural Economics (Fellow on leave).

JOSÉ A. SERRANO, B. Agr.,
Assistant in Agronomy.

ISABELO SONZA, B. Agr.,
Assistant in Agricultural Engineering.

ALBINO VARONA, B.S.A.,
Assistant in Agronomy.

LEOPOLDO J. VILLANUEVA, B. Agr., B.S.A.,
Assistant in Chemistry (Fellow on leave).

CLEMENTE E. YANGO, B. Agr., B.S.A.,
Assistant in Agronomy.

LAURO YNALVEZ, B. Agr.,
Assistant in Chemistry.

TEACHERS

JOSÉ BONDOC, B. Agr., (Graduate of Phil. School of Arts and Trades),
Teacher in Carpentry.

NICANOR M. CASTILLO, B. Agr., B.S.A.,
Teacher in Mathematics (U. P. R. H. S.).

SISENANDO REANTASO, B. Agr.,
Teacher in Animal Husbandry (U. P. R. H. S.).

PASCUAL ROBIN, B. Agr.,
Teacher in Horticulture (U. P. R. H. S.).

ALBINO VIDAL, B.S.A., (Graduate of Phil. School of Arts and Trades),
Teacher in Blacksmithing.

THE FINANCING OF THE COLLEGE

The College of Agriculture is financed altogether by government appropriations, usually as a part and parcel of the University of the Philippines, and occasionally by direct appropriation. Discussion on this point will be under the sub-heads of improvements and maintenance.

IMPROVEMENTS

The earliest appropriation on record is ₱10,000 set aside by the Board of Regents out of the ₱100,000 appropriated in Act 1870 founding the

Photographic Section, Air Corps, U. S. Army.

College Campus from the Air

University of the Philippines. This was for the purchase of the first land of the College.

One of the first direct appropriations received by the College from the central government was for the construction of a road to the College site from about Kilometer Post 66 on the Manila South Road. The College is located about two kilometers southwest of this junction. This road, as well as the first two permanent buildings of the College—the Administration Building and the Engineering Building—were constructed by the Bureau of Public Works.

Act 2059, enacted on February 3, 1911, appropriating money for government public works, contains the following items for the College of Agriculture:

₱ 8,000 for the construction of a stable, and
₱14,000 for the construction of an irrigation system.

Act 2264, approved February 11, 1913, which appropriated funds for public works and permanent improvements for the government in general, contains the following items:

College of Agriculture laboratory (now housing the Auditorium and the Department of Plant Physiology)	₱30,000
Irrigation system, roads, and bridges	₱25,000

On February 28, 1914, the Legislature approved Act 2378 for various public improvements. This included ₱30,000 for a laboratory for the College, which was used in the construction of the Seed and Harvest Laboratory.

The Public Works Act, No. 2494, approved February 5, 1915, appropriated ₱4,000 for a tobacco house.

A similar Act, No. 2583, and approved February 4, 1916, appropriated ₱30,000 for the construction of an agronomy laboratory building.

Through the sponsorship of the Honorable Guillermo F. Pablo, the Legislature passed Act No. 2730, on February 15, 1918, establishing the Experiment Station of the College of Agriculture and appropriating ₱125,000. This enabled the College to acquire a large tract of land aggregating about 260 hectares for the development of its experimental work, experimental animals, and to begin the construction of the entomology-pathology and chemistry laboratories, as well as a hog barn. This is the biggest appropriation made by the Legislature direct to the College.

The Public Works Appropriation Act No. 2898, approved on February 25, 1929, appropriated the following for the College:

Dormitories for students of the College of Agriculture	₱36,000
Completion of Chemistry Laboratory	₱20,000
Completion of Entomology-Pathology Laboratory	₱20,000

In 1921 the Board of Regents appropriated ₱40,000 out of the general funds of the University for the construction of an Animal Husbandry building.

The last appropriation made by the Legislature direct to the College was in response to an appeal of the late Dean Baker for improvements of which the College was sorely in need. The late Governor-General Wood took a personal interest in this, and largely through his influence and that of Senate-President Quezon the Legislature passed Act No. 3303, on December 2, 1926, appropriating ₱100,000 for permanent improvements in the College of Agriculture. This amount was apportioned by the Board of Regents as follows:

Two student dormitories	₱30,000
Power Plant	₱10,000
Completion of Engineering building	₱10,000
Chemistry lecture room and experiment station laboratory	₱15,000
Biochemical laboratory	₱10,000
Armory and Gymnasium, partial	₱25,000

Through an understanding with the Legislature, the University of the Philippines is no longer included in the general public works appropriation; instead its buildings are financed from tuition fees paid in by students. The College of Agriculture has recently been the recipient of funds as follows:

1927—Experiment Station bridge	₱15,000
1927—Student toilet	₱ 2,000
1928—Campus bridge	₱21,000
1929—Reservoir	₱ 8,000
1929—Laboratory at Limnological Station	₱ 2,000

The Vocational Education Act No. 3377, appropriated in 1928 ₱25,000 for the College of Agriculture for the training of teachers of agriculture. As it was not possible to organize the work at once, the greater part of the appropriation or ₱21,000 was utilized in the construction of the building housing the Department of Agricultural Education.

From time to time the Board of Regents appropriates money for the construction of faculty cottages. These are sold to members of the faculty on convenient time payments.

Minor buildings on the campus were either constructed from appropriations by the Board of Regents or from funds saved by the College from its maintenance outlay.

The following is a concise list of the major improvements on the College Campus, together with their approximate cost, classified by departments:

ADMINISTRATION

Administration Building	₱ 30,000.00
Bodega, gasoline	4,000.00
Bridge to Residential Campus	15,000.00
Bridge to Experiment Station	21,000.00
Light and power system	20,000.00
Roads, 8.4 km., at ₱8,000 per km.	67,200.00
Service shop	1,500.00
Water-works	25,000.00
	₱183,700.00

AGRONOMY	
Agronomy Building	₱ 30,000.00
Blacksmith shop	800.00
Implement bodega	20,000.00
Nursery house	10,000.00
Seed House	12,000.00
Soil Technology Laboratory	8,000.00
Tobacco House	4,000.00
	₱ 84,800.00
ANIMAL HUSBANDRY	
Animal Husbandry Building	₱ 35,000.00
Bridge to pastures	10,000.00
Cattle barn	7,000.00
8 chicken houses	4,000.00
Feed and implement barn	4,000.00
2 hog barns	2,000.00
Horse barn	5,000.00
Gate	1,000.00
Ice plant and butcher shed	1,000.00
Poultry Building	8,000.00
Poultry Building Annex	7,000.00
1 silo	1,200.00
	₱ 85,200.00
CHEMISTRY	
Chemistry Building	₱ 60,000.00
Balance shed	200.00
Biochemical Laboratory	10,000.00
Gas plant	1,500.00
Sugar house	10,000.00
	₱ 81,700.00
EDUCATION	
Agricultural Education Building	₱ 21,000.00
ENGLISH	
Old College Building	₱ 4,000.00
ENTOMOLOGY AND PATHOLOGY	
Entomology and Pathology Building	₱ 35,000.00
Insectary	600.00
Hawaiian Sugar Planters Insectary	4,000.00
	₱ 39,600.00
PLANT PHYSIOLOGY	
Plant Physiology Building	₱ 30,000.00
RURAL ENGINEERING	
Rural Engineering Building	₱ 54,000.00
DEPARTMENT OF MILITARY SCIENCE	
Temporary armory	₱ 6,000.00
Armory and gymnasium (incomplete)	25,000.00
	₱ 31,000.00
MISCELLANEOUS BUILDINGS	
Band stand	₱ 1,500.00
17 faculty houses	40,000.00

A part of the Student Body, College of Agriculture

1 mess hall (Molawin Hall)	5,000.00
9 student bungalows	27,000.00
4 student dormitories	54,000.00
4 bath houses	10,000.00
	₱137,500.00

An approximate valuation of the entire College plant is as follows:

Buildings and other improvements	₱752,500.00
Land (estimated value at ₱300 per hectare)	119,148.00
Equipment	220,000.00
Total	₱1,091,648.00

MAINTENANCE

In the beginning the appropriations for the different units of the University of the Philippines were apportioned by the Legislature. From about 1912 they were given in a lump sum and the Board of Regents distributed them to the different units of the University. The following table shows the total appropriations made to the University, the portions allotted to the College of Agriculture, and the proportion of these to the whole for the years 1919–1929.

University of the Philippines Appropriations
1919—1929

YEAR	TOTAL FOR U. P.	COLL. OF AGRICULTURE	PROPORTION
	Pesos	*Pesos*	*Per cent*
1919	1,370,720	318,820	23.26
1920	1,330,000	402,880	30.29
1921	1,450,000	389,290	26.85
1922	1,450,000	339,304	23.40
1923	1,573,000	365.730	23.25
1924	1,573,000	360,274	22.90
1925	1,580,000	381,186	24.13
1926	1,800,000	377,310	20.96
1927	1,800,000	373,660	20.76
1928	1,944,000	347,382	17.87
1929	1,964,000	371,700	18.93

It is evident that the College share in the University appropriation has grown smaller on the whole, not only in proportion to the appropriation of the University, but also in actual amount. The above appropriations are largely for maintenance, salaries, supplies, and equipment; not for building and permanent improvements.

INSTITUTIONS ALLIED TO THE COLLEGE OF AGRICULTURE AT LOS BAÑOS

Since the establishment of the College of Agriculture at Los Baños a number of similar organizations came to appreciate, not only the natural advantages of the location, but also the mutual advantage of close association with the College of Agriculture. Accordingly the Forest School, the College of Veterinary Science, and the Maquiling National Botanic Gardens were located in Los Baños.

The Forest School.—This school opened its doors on June 12, 1910 as a part of the College of Agriculture in response to the need of technically trained employees for the forest service. Its attendance consisted mostly of pensionados who upon graduation were employed by the Bureau of Forestry. The school continued as a part of the College until April 1, 1916, when Act No. 2578, passed on February 4, 1916, established it as an entity separate from the College of Agriculture, but still a part of the University of the Philippines.

During the time it was a part of the College, it graduated the following students:

1912	17
1913	29
1914	32
1915	20
1916	24

A more detailed history of this School is found elsewhere in this issue.

The College of Veterinary Science.—This College was originally located in Manila. On March 31, 1919, the Board of Regents passed a resolution transferring the College to Los Baños. The first and second year classes were started in Los Baños on July 7, 1919. Dean C. F. Baker of the College of Agriculture was appointed Acting Dean of the College on June 13, 1919, and remained in office during the first months of its life in Los Baños. A full history of the College appears in another article.

The Maquiling National Botanic Gardens.—The territory covered by Mt. Maquiling containing 3,767.5323 hectares was set aside on November 21, 1910, by Governor General W. Cameron Forbes, by Proclamation No. 106 as the Maquiling Forest Reserve. The intention was to reserve it as a laboratory for the newly organized School of Forestry. On November 30, 1920, Governor General Francis Burton Harrison by Proclamation No. 60 changed its name to the present one with the aim of increasing its importance and the scope of its usefulness. Its administration was placed in the hands of a board of which the ex-officio chairman is the Director of Forestry.

The Los Baños Limnological Station.—This is a station located on the shore of Laguna de Bay, Los Baños, for the study of fresh water flora and fauna. It is a part and parcel of the College of Agriculture and was organized early in 1929 as an activity of the Department of Entomology—Zoölogy. Its work at present is confined to fishes, but it will be extended soon to other forms of life found in the lake.

Aside from the above institutions permanently located on the Campus, from time to time the College is visited by scientists engaged in making collections. Botanists, entomologists and herpetologists particularly have at one time or another found a "happy hunting ground" in Los Baños. The Hawaiian Sugar Planters' Association maintained for many years a corps of entomologists on the Campus for the purpose of studying and collecting parasites on insects injurious to cane. The government of Formosa and the Imperial Agricultural Experiment Station at Tokyo, Japan, have been engaged in similar work on parasites of insects injurious to cane and rice. This latter work is still going on.

The College is always ready to extend a hand of welcome to visiting scientists on a casual or prolonged stay, and places at their disposal all facilities available.

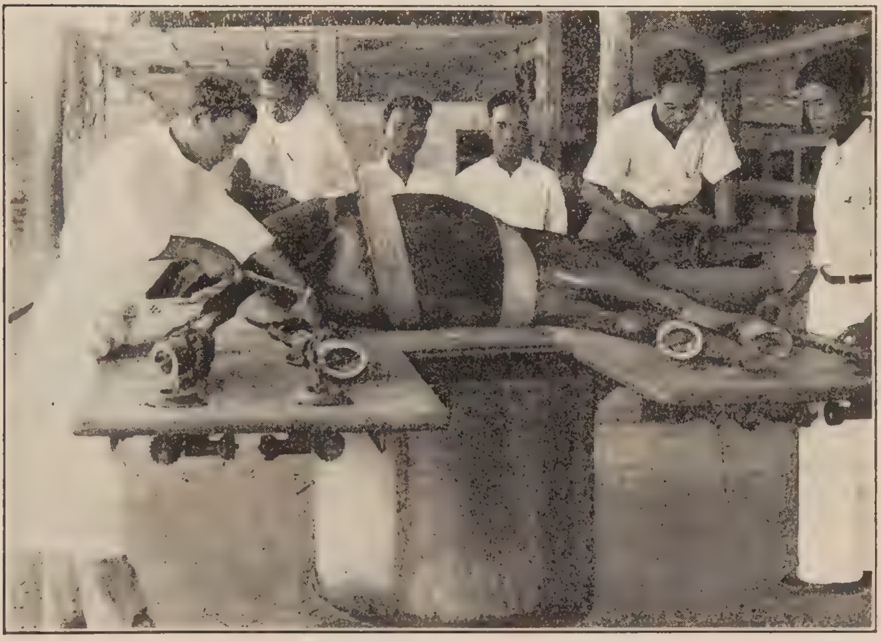
THE PHILIPPINE AGRICULTURIST

The Philippine Agriculturist was first issued in January, 1911, as a student publication supervised by the faculty. It publishes mostly the results of original investigations by faculty and students of the College. In 1917 it was taken over by the College as its official publication. Except for an interruption of one year on account of financial difficulties, it has been issued continuously and is now in its eighteenth volume and year. It has published over 6,200 pages of reports of experiments conducted, mostly, on the premises.

The total number of published contributions of the College from its foundation to the end of the last academic year was 595 experiment station contributions and 216 general contributions. The majority of these were published in *The Philippine Agriculturist.*

THE COLLEGE OF VETERINARY SCIENCE

GREGORIO SAN AGUSTIN
Dean, College of Veterinary Science



Treating a case of spavin, College of Veterinary Science

The College of Veterinary Science, which was created by an act founding the University of the Philippines on June 18, 1908, should have been opened in 1909; but because of shortage of certain equipment and of housing facilities, it was unable to begin work until June, 1910. Personnel of the Bureau of Agriculture took charge of instruction under the acting deanship of Dr. Archibald Robinson Ward, who later became dean up to 1914.

Before the College opened its doors, circulars setting forth the objects and the future of veterinary medicine and entrance requirements had been sent out to various division superintendents of the Philippine public schools. Completion of high school course of the Bureau of Education or its equivalent, which was determined by presentation of certificates or by passing on examination given by the College, was necessary for admission. The curriculum required five years' work, on the completion of which the degree of Doctor of Veterinary Medicine (D.V.M.) was granted. The following was the schedule of courses:

FIRST YEAR

First Semester	*Units*	*Second Semester*	*Units*
Chemistry 1	3	Chemistry 1	3
Physics	3	Physics	3
English 1	3	English 1	3
Zoology	3	Zoology	3
Mathematics 9	3	Anatomy	5
Osteology	3	Botany 1	3
Total	18	Total	20

SECOND YEAR

Chemistry 2	3	Chemistry 2	3
French 1 (optional)	3	French 1 (optional)	3
Histology	3	Embryology	3
Anatomy	5	Anatomy	5
Language of Medicine	1	Chemistry 9	3
Chemistry 9	3		
Total	18	Total	17

THIRD YEAR

Anatomy	5	Bacteriology	5
General Pathology	6	Preventive Medicine	1
Preventive Medicine	1	Animal Husbandry	2
Animal Husbandry	2	Physiology, Veterinary	3
Physiology, Veterinary	3	Pharmacology 3	5
Total	17	Total	16

FOURTH YEAR

General Surgery	4	Small Animal Diseases	2
Medicine	5	Obstetrics	4
Clinical Diagnosis	2	Medicine	5
Medical Entomology	2	Clinical Diagnosis	2
Clinics	5	Jurisprudence	1
Materia Medica	2	Clinics	5
Total	20	Total	19

FIFTH YEAR

Regional Surgery	2	Regional Surgery	2
Surgical Exercises	1	Surgical Exercises	1
Medicine	5	Medicine	5
Horse Shoeing	2	Opthalmology	1
Special Pathology	2	Therapeutics	2
Clinics	5	Clinics	5
Milk Inspection	2	Milk Inspection	2
Haematology	1	Infectious Diseases	2
Total	20	Total	20

Because the possibilities of the profession were little known at that time, there was then no enthusiastic response. The College in its first year had only ten students. The Government, however, realizing the

Castrating a native carabao bull, College of Veterinary Science

important mission of the College, created a scholarship fund by Act No. 2040, which was enacted February 3, 1911, by the Second Philippine Legislature. The following are its salient features:

> An Act to appropriate the sum of ₱3,500 for the creation of Government Scholarship in the College of Veterinary Science of the Philippine University.
>
> Sec. 1. Twenty-five Government Schoolarships for Filipinos are hereby created in the College of Veterinary Science of the Philippine University to be filled subject to the rules provided by the Board of Regents of said University; provided that there shall not be more than ten of the scholarships for the first year of said college.
>
> Sec. 2. The sum of ₱3,500 is hereby appropriated out of any funds in the Insular Treasury not otherwise appropriated to carry out the provisions of this Act mentioned in the preceding section during the first year.
>
> Sec. 3. The public good requiring the speedy enactment of this bill, the same shall take effect on its passage in accordance with Sec. 1 of Act. 145 of the Philippine Legislature.

In 1914, by Act No. 2302, of the Third Philippine Legislature, the number of scholarships was reduced from 25 to 20 valued at ₱35.00 each. Besides the Insular Government scholarships, there were also created municipal and provincial, as well as private scholarships, such as those given by Mr. Limjap.

The College was originally quartered in three reënforced concrete buildings, adjoining the quarantine yards of the Bureau of Agriculture in Pandacan. These housed the lecture room, the anatomy laboratory, and the clinics. A large part of the first three-year work in laboratory subjects was given in the old Philippine Medical School, which has since been incorporated with the University of the Philippines as the College of Medicine and Surgery.

In 1913, under the same dean, the buildings adjoining the San Lazaro Hospital, at the corner of Tayuman Street and Rizal Avenue, were acquired. Classes thereafter were held both in Pandacan and in San Lazaro. In 1914, the College completely abandoned its buildings in Pandacan. In San Lazaro, it occupied a two-story building which housed the faculty offices, class rooms, and anatomy laboratory. In addition, there were large sheds and stables for large-animal and small-animal clinics, and properly screened stables for quarantining animals suffering from infectious and contagious diseases. Additional laboratory instruction in the allied sciences was given at the College of Medicine and Surgery.

In the same year, upon the resignation of Doctor Ward, Dr. William H. Boynton was appointed dean. During the first semester, he took leave, and Dr. Eustace S. D. Merchant was made acting dean. Classes were continued in Manila until the year 1919, when the Board of Regents, believing that the College would give greater benefit to the country by operating it side by side with the College of Agriculture, passed a resolution transferring it to Los Baños. As an initial step toward this end, the first and second years were conducted in Los Baños, and classes for the third, fourth, and fifth years in Manila. The College was then divided, with Dr. Angel K. Gomez as in charge at Los Baños and Dr. Victor Buencamino in charge of the Manila branch. In 1919 another significant event happened when the College was recognized and added to the list of accredited veterinary colleges in the United States. The following year brought the entire college to Los Baños. The Dean of the College of Agriculture, the late Charles Fuller Baker, was acting dean of the College during its organization in Los Baños.

In 1920 a number of experienced professors resigned, rather than stay in Los Baños. They were replaced by new graduates imported from the United States under the acting deanship of Alonzo S. Shealy, who was made permanent dean the following year.

A concrete single-story building situated at the entrance of the College Campus lodged the laboratories for pathology and bacteriology, pharmacy, and some of the faculty offices. A large nipa shed with several stalls served as temporary quarters for the hospital and feed room. The other departments and laboratories were housed in buildings of the College of Agriculture. The two colleges worked in close coöperation; reciprocal courses were given for the students of both institutions.

From 1919 to 1924, the enrollment of the College steadily declined to such an extent as to give some concern to the authorities of the University.

The Board of Regents formed a special committee from the Colleges of Veterinary Science and Agriculture to investigate the feasibility of uniting the two Colleges. After a thorough investigation, the Board of Regents followed the recommendation of the committee that the College of Veterinary Science should remain separate. The following month, however, the same question was again taken up. The special committee, which was already formed, met on August 19 and on October 23, 1924. The result was a recommendation, which was approved by the Board of Regents on October 30, 1924, as follows:

> The length of time prescribed for graduation in the College of Veterinary Science, which is five years, is not commensurate with the limited opportunities now open to scientific veterinarians, and if the college is to remain open indefinitely, its courses should be shortened to four years.

Doctor Shealy having resigned in 1924, Dr. Gregorio San Agustin was made acting dean and in 1925, permanent dean. In compliance with the resolution of the Board, the course was shortened from five to four years. It will be noticed from the following curriculum, when compared with the five-year course, that only the cultural courses were eliminated. The other changes were mere consolidations of courses with the same subject matter. The curriculum was, moreover, greatly strengthened in animal husbandry and in parasitology.

THE FOUR-YEAR CURRICULUM

Leading to the degree of Doctor of Veterinary Medicine (D. V. M.). Open to graduates of approved four-year secondary schools

FIRST YEAR

First Semester	*Hours*	*Units*	*Second Semester*	*Hours*	*Units*
A. Chem. 1a	9	5	A. Chem. 1b	9	5
V. Zool. 1	9	5	V. Hst. 1	8	4
V. Anat. 1	11	5	V. Anat. 2	14	6
V. Embr.	5	3	V. Bot.	2	2
			A. Husb. 1	3	3
Total	34	18	Total	36	20

SECOND YEAR

A. Chem. 3	9	5	A. Chem. 3	9	5
V. Anat. 3	11	5	V. Anat. 4	8	4
V. Bact. 1	8	4	V. Bact. 2	8	4
A. Husb. 2	6	2	V. Phs. 1 (B)	4	2
V. Phs 1. (A)	5	3	V. Phar. 1	5	3
			A. Husb. 2	6	2
Total	39	19	Total	40	20

THIRD YEAR

V. Phar. 2	6	4	A. Husb. 4	3	3
V. Med. 1	2	2	V. Med. 2	3	3
V. Path. 1	8	4	V. Path. 1	4	2

V. Clin. Diag.	3	3	V. Surg. 1	3	3
V. Parasit. 1	4	2	V. Parasit. 2	4	2
A. Husb. 3	3	3	H. Shoeing	3	1
V. Clin. 1	9	3	V. Hyg. 1	3	1
			V. Clin. 2	15	5
Total	35	21	Total	38	20

FOURTH YEAR

V. Hyg. 2	1	1	V. Jur.	1	1
V. Surg. 2	3	3	V. Hyg. 3	1	1
V. Path. 2	2	2	V. Surg. 2	3	3
V. Med. 3	2	2	V. Med. 5	5	5
V. Med. 4	3	3	V. Obst.	3	3
V. Parasit. 3	4	2	V. Path. 3	4	2
V. Surg. 3	5	1	V. Autop. 2	3	1
V. Autop. 1	3	1	V. Clin. 4	15	5
V. Clin. 3	15	5			
Total	38	20	Total	35	21

To date the enrollment of the College has been as follows:

Year	*Enrollment*
1910	10
1911	14
1912	27
1913	31
1914	28
1915	30
1916	35
1917	90
1918	92
1919	73
1920	80
1921	73
1922	74
1923	47
1924	34
1925	46
1926	68
1927	82
1928	90
1929	95

It will be noticed that since the inauguration of the new curriculum, in 1925, enrollment has been steadily improving. Other improvements have been in the form of additional buildings for accomodation of the small-animal clinic, post-mortem examination, horseshoeing, recovery ward, and quarantine were constructed. Shortly after, the departments of anatomy, parasitology, and physiology, that had been lodged in some of the buildings of the College of Agriculture, were moved to a new one-story building, situated at the entrance of the College Campus, opposite the first concrete building of the College which was constructed upon its transfer to Los Baños.

The Board of Regents on October 14, 1926, approved the reduction of allowance in government scholarship from ₱35.00 to ₱25.00 each, the amount saved to be used to defray the expenses of one or more members of the faculty pursuing post-graduate work abroad.

In 1926, the six-year combined veterinary and animal husbandry curriculum was introduced. The first four years of work are taken at the College of Agriculture, at the conclusion of which the degree of B. S. Agr. is granted; the last two years, at the College of Veterinary Science, leading to the degree of D. V. M.

Veterinary graduates have been in demand and the College is now better equipped than ever before both in laboratory and lecture facilities. Indeed, with the present improved condition, it can be said that the future of the College of Veterinary Science and its graduates is assured. This is due partly to the growing knowledge of the Filipinos regarding veterinary medicine and the expanding interest in animal industry and agriculture. The graduates of the College are all holding positions of responsibility, the majority of them connected with the Bureau of Agriculture, Bureau of Education and University of the Philippines. Some, however, are engaged in private practice. There are at present 108 graduates of the College of Veterinary Science. Five others were taken from the ranks by death.

The financial support which the College has been getting is not commensurate with its growth. The enrollment of the present academic year is very much higher than that of 1921–1922; but the appropriation is 39 per cent less than in that year.

The College of Veterinary Science is the only one of its kind in existence in this country and considering the fact that it has a definite function to perform in our national life in relation to agriculture, whole-hearted and generous support should be given in order to make this institution a first class center of investigation and research along lines of veterinary medicine. Japan has considerably smaller animal population than ours in the Philippines, and yet that country supports twenty-one veterinary schools. To carry out successfully our program of investigation and research, it has been our aim to provide the institution with a sufficient number of highly trained men to constitute the faculty. It is only by this means that our people can look to us with confidence and reliance for the solution of the many complex problems which seriously affect the live stock industry in the Philippines.

THE FOREST SCHOOL

ARTHUR F. FISCHER

Director of Forestry and Dean, School of Forestry

After the establishment of the Bureau of Forestry under General Orders No. 50 by the Military Government (being the first government bureau established under the American flag), it was soon apparent that trained field personnel was needed. A few of the rangers of the old Spanish "Inspección de Montes" were retained and an organization was effected. Technically trained university men from the United States were recruited for the forestry work and discharged volunteer officers and men were employed for administrative assistants. Filipino personnel for rangers and guards were recruited by the technical and administrative American personnel in the districts where they worked. It soon became evident to the higher staff that it was too great a burden to teach and train Filipinos who lacked the necessary background while carrying on their daily tasks in the field.

Forester R. C. Bryant (now Manufacturers' Association Professor of Lumbering at the Yale Forest School) while Assistant Director of Forestry in 1903, established the Lamao Forest Reserve for technical and scientific studies with the additional purpose of using it as a training ground for Filipino personnel and finally establishing a school. This school did not materialize but was discussed. In the Foresters' Conference of 1909 it was again taken up. Forester Hugh M. Curran and Dr. E. B. Copeland looked over the available areas in the vicinity of Manila with the object of locating a site for an agricultural college with a forestry department. Los Baños was chosen, the land acquired and the forest reserve established.

Forester Royal F. Nash, on December 13, 1909, wrote a lengthy letter to the Director of Forestry, urging the immediate establishment of the school, in which he says:

"The facts that make such a school an imperative need are so patent that the matter requires little discussion.

"Dr. Fernow gives a concept of government which is peculiarly applicable to the Forest Service, namely, 'the instrument to secure the possibility of not only social life but of social progress, the representative of communal interests as against private interests, of the future as against the present.' That is a concept which every forest officer should have as a background to each decision that he makes, the progressive and abiding interests of society should be more concrete to him than the most urgent demand of any individual in conflicting interest; but it is a thought that does not come to the uncontemplative mind. It takes study to assimilate a sufficient quantity of the world's accumulated knowledge to be able to look at problems from a universal vantage point; close pondering over the facts of the world's needs compared to the world's supply is necessary before a man who has always lived in sight of an extensive virgin forest can see the need of utilizing the forest economically; nevertheless, this is a viewpoint which must be injected into every vein and capillary of this forest service before it will begin to subserve its proper social functions.

"Second only in importance to his social philosophy is a forest officer's understanding of the natural forces which he endeavors to utilize and to mould. He must have knowledge of the changes taking place constantly in the forms of the land itself, of the life processes of the forest growth which spring therefrom. More than this, he must know how to utilize nature so as to subserve social needs most economically.

"Yet having all this, his philosophy, his understanding, his technique may still amount to naught unless he combines therewith knowledge of how to live, the faculty of getting on with men, and above all a high appreciation of the value of his work.

"The executive work of the forest service here, as in India, is being done and should continue to be performed by native rangers. Their efficiency measures precisely the efficiency of the organization as a whole; the finest calibre of intelligence in the directing staff amounts to nothing if the subordinates who must be relied upon to carry out directions are innocent of all the qualifications I have above outlined.

"To expect the American foresters to impart the requisite discipline to their subordinates while attending to the multiple details of administration, is to build on a foredoomed hope. India tried that fallacious plan; we do not need to duplicate her mistakes.

"Of absolute necessity, I repeat, then, is the immediate founding of a Philippine School of Forestry, a necessity so paramount we could well afford to drop entirely our dabbling administrative efforts for a year, if necessary, to secure the requisite funds. The opportunity is made easy by the presence of the Agricultural College at Los Baños, the site chosen as most available for a forest school."

This letter resulted in definite action and a course of study as follows was submitted to the Board of Regents of the University, on February 15, 1910:

Junior Year		*Vacation*	*Senior Year*	
Physiography and Soils	Physiography and Climatology of the Philippines	Lumbering	Wood Technology	
Geometry	Trigonometry and Surveying	Forest Mensuration	Surveying	Forest Engineering
Forest Botany	Silvics	Horses, Camps and Packing	Silviculture	
Mapping	Law and Procedure		Forest Economy	

Forester Nash was assigned as instructor of forestry in charge of the Forest School of the College of Agriculture, in June, 1910. Students were selected from eligibles throughout the Islands and paid ₱20.00 per month, with quarters. The students reported by June, 1910, and the school was a fact. Nipa houses were used for quarters, mess hall and class rooms in the Agricultural College. The Division of Investigation was transferred to Los Baños early in 1911 and Dr. H. N. Whitford, the chief, with Forester H. M. Curran and Dr. F. W. Foxworthy, were available for instruction in

School of Forestry campus, showing students' dormitories; Mt. Banahao in the background

School of Forestry students in nursery work forestry subjects. Forester Nash resigned from the service and Forester D. M. Matthews was assigned to take his place. The writer, soon after his arrival in August, 1911, was assigned to the Division of Investigation and taught in the Forest School.

Some ten Chinese students supported by Chinese funds were graduated for work in China, two Chamorros from Guam, and the British North Borneo Government supported Filipinos under scholarships for their Forest Service, of whom some eleven were graduated.

In 1914, the School granted two B. S. F. degrees, to Antonio P. Racelis and Aniceto Villamil. The higher course leading to the degree of B. S. F. was formally instituted in June, 1923, graduating José F. Nano in that year and was made to conform to standards of the forest schools of the United States. Four men were graduated in 1928 from this course.

The total number of graduates of the Forest School is 381, of whom 232 are employed in the Bureau of Forestry, 17 with lumber companies and 23 in foreign countries in forestry. Many of the graduates are serving in various Government bureaus, the Manila Railroad, and as officers in the U. S. Army and the Constabulary.

Since the year 1912 the Forest School has annually graduated classes of about twenty men, who have all received appointments as rangers in the Bureau of Forestry.

The Forest School was under the College of Agriculture until April 1, 1916. On February 4, 1916. Act No. 2578 was passed, creating a school in the University of the Philippines to be known as the Forest School, which shall embrace all work hitherto carried on in the Forest School of the College of Agriculture of the University of the Philippines. The school buildings and quarters are located within the Maquiling Forest Reserve, thus making the Reserve, which embraces the entire public forest on Mount Maquiling, containing many of the principal forest types of the Philippines, available and easily accessible to the students for all kinds of field work necessary for a complete course in forestry, with the exception of steam logging and sawmilling; for field work of this nature, some extensive lumbering operation is chosen.

The Forest School is filling successfully its mission in preparing men for public and private service in Forestry and its allied industries. Much of the reputation of the Bureau of Forestry is due to the School and its character-forming qualities, the results of which are seen in the work of its graduates.

HISTORIES OF DEPARTMENTS
COLLEGE OF AGRICULTURE

Department of Agricultural Chemistry
Department of Agricultural Education
Department of Agricultural Engineering
Department of Agronomy
Department of Animal Husbandry
Department of English
Department of Entomology
Department of Military Science and Tactics
Department of Physical Education
Twenty Years of Athletics in the College of Agriculture
Department of Plant Pathology
Department of Plant Physiology
Department of Rural Economics

DEPARTMENT OF AGRICULTURAL CHEMISTRY

F. O. SANTOS

Associate Professor of Agricultural Chemistry and Acting Head of the Department

The first curriculum offered in the College of Agriculture provided for two successive one-year courses in chemistry in the third and fourth years. Since several students entered with advanced credits, Chemistry 1 had to be given in the second year of the life of the College. Accordingly a laboratory and lecture course on this subject was given in 1910-1911 in one of the ground-floor rooms of what is now known as the Old College Building.

As there was no regular instructor in chemistry, Richard M. Holman, instructor in botany, took charge of the work. He was assisted by an advanced student, Silvestre Asunción.

In the 1910-1911 catalogue, chemistry was listed as a Department. It was then occupying half of what is now known as the Engineering Building. "It has a main room, fitted for eighty students, and a small room. It has the ordinary equipment for elementary and advanced work in general, analytical and agricultural chemistry, including the study of soils, sugar, starch, alcohol and digestion experiments."

On July 8 of the same year Dr. Horace G. Deming, associate professor of chemistry, arrived from the United States and took charge of the Department.

In November, 1911, Manuel L. Roxas (B. S. A., 1911), formerly student assistant in mathematics, was appointed assistant in chemistry. In line with the College policy of preparing Filipinos for responsible positions, Manuel L. Roxas was sent to America in July, 1914, for advanced work in chemistry. Francisco Quisumbing (B. Agr., 1914) was appointed assistant on June 15, 1914. In 1915 Professor Deming arranged for the temporary transfer of Quisumbing to Manila to prepare him better for advanced work abroad. To enable the Department to handle the increasing number of students, three additional members of the staff were appointed during that year. These were Fred W. Ashton, Guy Clinton, and Pedro Montellano. Doctor Deming and Mr. Clinton resigned in 1916 and Mr. Montellano in 1918. Part of Professor Deming's excellent textbook on general chemistry was prepared during his stay in the Department.

After the return of Dr. Manuel L. Roxas from the University of Wisconsin, he began injecting new and vigorous blood into the Department. He believed that the Agricultural Chemistry Department existed not only for the teaching of chemistry, but for general service to the country as well.

At once he begun the prosecution of two major lines of work, namely, the training of students for teaching chemistry and for technical positions in chemical industries, and the chemical investigation of Philippine agricultural problems. His ability and enthusiasm attracted many graduate students. In 1917, F. Quisumbing returned from Manila to take advanced work under him. After Quisumbing obtained his M. S. degree from the College, he was sent to Columbia as a fellow of the University. Doctor Roxas saw to it that every promising student was sent to the United States after getting the M. S. degree. F. O. Santos, Doctor Roxas' second pupil, obtained his M. S. in 1919 and was sent to Yale the same year. C. Alincastre obtained his M. S. in 1920 and was sent abroad that year.

By 1916 the Department was already occupying all of "the first laboratory built for the College, which originally housed Chemistry, Botany, Physics and Agricultural Engineering (now known as the Agricultural Engineering Building). There is space for 108 students in Chemistry 1 and a total of almost as many more advanced students. It is well equipped with apparatus for advanced work in general agricultural chemistry and in the chemistry concerned with the utilization of various agricultural products, especially sugar."

To enable the Department to prepare promising students for advanced work abroad more courses were offered and the elementary ones revised. By 1917 seven chemistry courses were already listed in the catalogue. A course in biological chemistry and another in sugar chemistry were offered to advanced students as electives. Doctor Roxas believed in a well balanced Department and for this reason Quisumbing was advised to major in analytical chemistry, Santos in biological chemistry, and Alincastre in sugar chemistry.

In considering ways and means by which the Department could be of greater service to Philippine agriculture, Doctor Roxas saw the immediate necessity of having men prepared for responsible positions in the Philippine sugar industry. He organized a five-year course in sugar technology, which was first opened to students in 1920. This year was probably selected as the opportune time for opening the course, so that by the time the students were ready to take new courses in the Department, the men sent abroad would have returned and be prepared to help in teaching and other work.

By 1919, the enrollment in chemistry had greatly increased, and the staff had to be increased accordingly. Miss Hazel Kenward was appointed in January of that year, and stayed until April, 1923. Mrs. Flaviana del Rosario-Navarro was appointed instructor in October, 1920, and stayed until June, 1921. During these formative years it was the policy to retain some of the promising graduates and accordingly, Esteban Collado (B. Agr., 1919) and Victor Sulit (B. Agr., 1919) were appointed assistants.

Early in 1921 the Department was transferred to its present location; and in October of the same year Professor Ashton resigned, thus leaving

Analytical Laboratory, Department of Agricultural Chemistry

Doctor Roxas in full charge of the Department. The new building with plenty of room for the time being, and the new equipment acquired gave added impetus to research which began to take more rapid strides. For the proper coördination of the work the Department was separated into its present divisions, namely, (1) General and Physical, (2) Analytical (including Experiment Station) (3) Organic and Biological, and (4) Sugar Technology.

Dr. F. Quisumbing, who returned from Columbia in 1921, was put in charge of the Analytical Division; and Doctor Santos, who returned from Yale in 1922, was assigned to Organic and Biological. Doctor Roxas took charge of Sugar Technology and pending the appointment of a man for General and Physical Chemistry, the work of this Division was taken jointly by Doctors Roxas and Santos.

The increase in the teaching work and the big demand in the Experiment Station section of the Analytical Division made the appointment of an analyst necessary and to this position Dr. Felipe T. Adriano was appointed in August, 1922. Unfortunately, however, Dr. F. Quisumbing removed to the College of Liberal Arts in October, 1922, and so Doctor Adriano had to be placed in charge of the Analytical Division. From this time on the Experiment Station section has had the services of two graduate assistants only.

In July, 1922, Mr. H. Henares, a pensionado of the College of Engineering, was appointed instructor to help Doctor Roxas in Sugar Technology.

And in January, 1924, Mr. Alincastre returned from the Audubon Sugar School, Louisiana State University.

Another man attracted by Doctor Roxas was Dr. Elias H. Pañganiban, B.Agr., 1915, who came from the Bureau of Agriculture. After obtaining his M. S., Pañganiban was sent to Cornell to specialize in Soil and Fertilizer Chemistry. He returned in December, 1924, and was placed in charge of the Analytical Division, while Doctor Adriano was sent to America for more advanced work in Analytical Chemistry. He returned in May, 1927.

In October, 1925, Dr. V. G. Lava, who was graduated from Columbia University, and was formerly physical chemist of the Bureau of Science, was appointed to the General and Physical Chemistry Division.

Year by year the Department increased not only in the size of its personnel, but also in quality, so that by 1926-1927 it had seven members of professorial rank, four instructors and seven assistants. Although most of the professors were men of experience, they were young in years with growing families, and their expenses were therefore increasing. Unfortunately for the Department, the University was not able to increase their salaries. Hence several members were forced by financial necessity to look for more remunerative positions. Alincastre and Henares moved to private sugar centrals, and Pañganiban went to farming. Then early in 1928, the Department suffered the greatest loss. Dr. M. L. Roxas, the head of the Department and the man to whom most of the growth of the Department was due, took advantage of the Osmeña Retirement Act, and was subsequently appointed Emeritus Professor.

Owing to the inability of the Department to get men qualified for the work, it has not been possible to replace the men who have resigned. So at present there are only four members with professorial rank, six instructors and eight assistants.

The following workers were connected with the Department for some time:

Mrs. Concepción Maramba Henares, instructor
Elias Caray, assistant
Delfin Divinagracia, assistant
Severino Etorma, assistant
Francisco de Jesus, assistant
Victorino Kilayco, assistant
Gil Opiana, assistant
Francisco Palad, assistant
Ciriaco Serrano, assistant
Eligio Ureta, assistant

Biochemical Laboratory, Department of Agricultural Chemistry

COURSES

In the college year 1910-1911, Chemistry 1, Elementary Chemistry, was the only course given by the Department. At present the following courses are offered:

1.	Agricultural Chemistry 1a	General Chemistry.
2.	Agricultural Chemistry 1b	General Chemistry.
3.	Agricultural Chemistry 2	Analytical Chemistry.
4.	Agricultural Chemistry 3a	Organic Chemistry.
5.	Agricultural Chemistry 3b	Intermediate Organic Chemistry.
6.	Agricultural Chemistry 4	Physical Chemistry.
7.	Agricultural Chemistry 5	Industrial Chemistry.
8.	Agricultural Chemistry 6	Chemistry of Sugars.
9.	Agricultural Chemistry 9	Elements of Glass Blowing.
10.	Agricultural Chemistry 99	Special Problems in Chemistry.
11.	Agricultural Chemistry 100	Undergraduate Thesis in Chemistry.
12.	Agricultural Chemistry 120	Agricultural Analysis (Soils and Fertilizers)
13.	Agricultural Chemistry 121	Agricultural Analysis (Foods and Feeds)
14.	Agricultural Chemistry 130	Biochemistry.
15.	Agricultural Chemistry 140	Colloid Chemistry.
16.	Agricultural Chemistry 199	Seminar in Chemistry.
17.	Agricultural Chemistry 300	Master's Thesis in Chemistry.
18.	Sugar Technology 1	Cane Field Practice.
19.	Sugar Technology 2	Technical Sugar Analysis.
20.	Sugar Technology 3	Thermodynamics.
21.	Sugar Technology 4	Mill Practice "A".
22.	Sugar Technology 5	Factory Management.
23.	Sugar Technology 6	Sugar Machinery Design.
24.	Sugar Technology 7	Mill Practice "B".
25.	Sugar Technology 100	Sugar Technology Thesis.
26.	Sugar Technology 199	Seminar in Sugar Technology.

EQUIPMENT

In every College department the most important asset is its personnel. But in a laboratory department, like Agricultural Chemistry, the equipment available to the members of the staff determines in no small measure their teaching efficiency, their productivity, and advancement in their chosen lines.

The present building, erected in 1921 when the classes were few and small, is already inadequate for the various needs of the Department. However, when the small yearly appropriation for the entire College is considered, it can be said that the Department has been getting its due share. Since 1921, an additional ell has been built, a separate biochemical laboratory constructed, and at this writing a permanent stockroom is being completed.

Every member of professorial rank has a small room for office and private laboratory. All the laboratories, for both students and professors, are furnished with electricity, gas, and water. The laboratory apparatus needed for teaching and research are being increased and improved gradually. Lately three Freas ovens have been received, and a new 5 H. P. electric motor for running the laboratory grinder, vacuum pumps, laboratory mill, and air pump has been installed.

Andelros Club Library

One of the needs of the Department is a good working library. Since the College Library itself is still small, it has not been considered wise to ask for one for the Department. So in 1923 the members of the Department organized the Andelros Club, principally for the purpose of maintaining a departmental library. The income of the Club comes from the following sources:

1. Yearly contribution of 5 per cent of one month's salary from every member.
2. One peso each from advanced students.
3. Every member receiving an increase in pay gives 10 per cent of one month's increase.
4. From time to time members of the Department give donations in the form of journals, books, and money.

The following journals are being received regularly:

1. Journal of Chemical Education.
2. Journal of the American Chemical Society.
3. Journal of Industrial Engineering Chemistry.
4. The International Sugar Journal.
5. The Cotton Oil Press.
6. Chemical Reviews.
7. General Electric Review.
8. Chemical Abstract.
9. Science.
10. Science News Letter.
11. Sugar.
12. Physiological Reviews.

Sugar Mill, Department of Agricultural Chemistry

THE SUGAR TECHNOLOGY DIVISION

Doctor Roxas' interest in sugar work was already manifest soon after his return from the United States. As soon as he was able to interest students in sugar work, he began the erection of a miniature central. The first one was made from tin cans, laboratory glassware, and other simple materials. The grinder was a small laboratory hand mill, the evaporators were made of tin cans, the vacuum pan was made of a 5-liter Pyrex flask attached to a vacuum pump; and the filter press was of analytical laboratory size. The centrifugal was also a small one, like those commonly used in a chemical laboratory. Later the tin cans were replaced by iron. As money became available and second-hand apparatus were obtained by purchase or donation from friends, the parts were replaced by better ones. So that by the College year 1922-1923 when the first Sugar Technology students were ready for sugar mill practice, the Deartment had "a small sugar house built behind the Chemistry Building for the manufacture of centrifugal sugar on a small scale. The sugar house is equipped with a six-roller mill, and a suitable number of defecators, settling tanks, evaporators, vacuum pan, centrifuge and crystallizers. The mill is run by steam supplied by a 20 H. P. boiler fired by a green-bagasse furnace."

Later on the Department was given a bigger grinder by Mr. Josefino de la Peña of Negros and a bigger centrifugal machine was obtained by purchase. Other improvements were designed by members of the staff, and the Earnshaw Docks and Honolulu Iron Works helped in their construction.

Several students have already been graduated from this course. About 50 per cent of the chemists in the sugar centrals in the Islands and the majority of the men engaged in experimental work in the sugar cane industry are either graduates or have taken special work in this course.

In the resignation of the members of the personnel mentioned above, the Sugar Technology Division suffered the most, as Doctors Roxas, Alincastre, and Henares were in this Division. There was a time when this division was in charge of only one assistant. It was hard to get a local man who knew Philippine conditions and who was properly qualified to teach Sugar Technology. The services of Mr. Reginald H. King, formerly of the Hawaiian Sugar Planters' Association, were secured. He is assisted by an instructor, Mr. Leandro S. Ebro, and an assistant, Mr. Eusebio Bataclan.

It is difficult to maintain an efficient personnel, as the remuneration from the University is much less than the sugar centrals are paying to sugar technologists.

At present the Department has two assistants taking advanced work in Sugar Technology in the Audubon Sugar School. One, Leopoldo Villanueva, is a pensionado of the Bureau of Justice and the other, Getulio Guanzon, is a fellow of the University. When they return, the Division will be much strengthened.

RESEARCH WORK AND EXTENSION

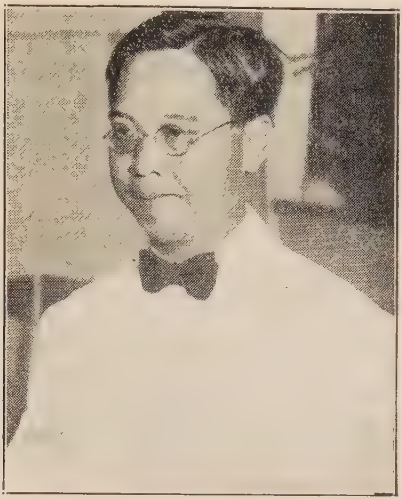
Besides teaching, the members of the Department have carried on research work on the following lines:

1. Studies on the different phases of sugar cane production and sugar manufacture with a view to improvement.
2. Studies on the utilization of Philippine raw materials and their by-products.
3. Studies on soils and fertilizers.
4. Studies on the nutritive value of different food materials in the Islands.

As the immediate needs of the country, and of agriculture in particular, are for what may be termed "applied research", investigations along more practical lines have been emphasized.

A list of the accomplishments of this Department may be found in the annual reports to the Dean and in the "Published Contributions for the College of Agriculture". They are along the following general lines:

1. Studies on cane varieties in the Philippines.
2. Studies on the effect of climate on cane yield.
3. Studies on root and shoot development of sugar cane.
4. Studies on cane maturity, on sucrose losses, on methods of inversion, on molasses constituents, on keeping quality of sugars, etc.
5. Studies on the use of fertilizers for different sugar cane soils.
6. Studies on oils, soils, fertilizers, foods and feeds.
7. The use of antimony electrode for pH determination in soils and sugar solutions.
8. Chemical analysis of Philippine food and feeding stuffs.
9. Sources of antiberiberi vitamin in Filipino food materials.
10. Studies on food requirements of Filipinos.
11. An improved copra drier.



Sugar News Press

MANUEL LUZ ROXAS
Professor of Agricultural Chemistry, emeritus

The Department has also engaged in extra-curricular activities such as extension and co-operation.

1. Different members of the Department have given lectures to visiting student groups; teachers' conventions, medical societies, sugar associations, nurses associations, etc.

2. Three popular pamphlets (on a new copra drier, on beriberi and on chemical composition of Philippine food materials) have been published.

3. The Department co-operates with the other departments of the College and with outside farmers in the analysis of food, feeding stuffs, soils and fertilizers.

4. From time to time members of the Sugar Technology Division have helped the sugar centrals in solving some of the difficulties encountered in their milling and chemical control.

5. The Department co-operates with the Bureau of Health in the control of beriberi.

6. The Department co-operates with the Office of the Public Welfare Commissioner in the study of nutrition of the Filipinos.

7. The Department co-operates with the Bureau of Forestry in the study of the utilization of forest products.

8. From time to time members of this Department have acted as consultants to merchants and manufacturers.

Molawin Hall:—Under the direct supervision of some members of the Department, a restaurant for the students is being run by the College. Foods on short order can be had at very reasonable prices. Regular board costs ₱17.50 a month. The business is self-supporting—even the present building is being paid for to the University by installments. Lately, from the proceeds of the operation, a radio loud speaker has been bought for the use of the student body.

The Hall has china and silverware, which are rented at nominal rates to members of the faculty and students. For the use of the Hall, nominal rates are also charged as follows:

1.	Use of a hall for dance only, from 8:30 to 11:30 a. m.	₱3.00
2.	Use of a hall for dance only, from 1:30 to 4:30 p. m.	3.00
3.	Use of a hall for dance only, from 8:30 a. m. to 4:30 p. m.	5.00
4.	Dance at night 8:00 p. m. to 12:30 a. m.	10.00

DEPARTMENT OF AGRICULTURAL EDUCATION

FELIPE O. CEVALLOS
Of the Department of Agricultural Education; on detail from the Bureau of Education

By virtue of Section 2, paragraph d, of the Vocational Education Act No. 3377 which was passed by the Seventh Philippine Legislature at its Third Session on December 3, 1927, the Department of Agricultural Education was created in 1929 at the College of Agriculture. The sum of ₱25,000 was appropriated as aid to the College, and this money was made available for the fiscal year ending December 31, 1928, for the establishment of this department.

The Department of Agricultural Education was established for the following objectives: (1) To train teachers and supervisors of secondary agriculture. Upon completion of the prescribed course or courses, these prospective teachers will be granted certificates in agricultural education qualifying them to occupy positions in the agricultural teaching service under the Bureau of Education. (2) To make careful study of all modern agricultural education subjects in order to promote agricultural education in the Philippine Islands. (3) To make careful study of all important literature and publications from the United States, noting principles that could be used to advantage for the improvement of agricultural education in the Islands. (4) To coöperate with the Bureau of Education in the matter of improving teachers already in the service.

In order to have adequate facilities for practice teaching, classroom and field work observations for the students in the Department, a model rural high school is maintained to which intermediate school graduates are admitted for agricultural training. This rural high school was opened on June 10, 1929, with a total enrolment of 190 in first and second years. The work of this model rural high school is run on the same basis as the regular rural high schools under the Bureau of Education, but with certain modifications in order to meet the needs of the students, of the prospective teachers, and of those pupils who expect to go beyond the high school.

Students who have finished all the required courses for the Bachelor of Science degree in Agriculture may become candidates for the certificate in Agricultural Education upon the completion of fourteen additional units, as follows:

COURSES	HOURS	UNITS
Agricultural Education 1	3	3
Agricultural Education 2	3	3
Agricultural Education 3	2	2
Agricultural Education 4	3	3
Agricultural Education 5	3	3
Agricultural Education 6	3	3
Total	17	17

The above courses may be taken as free electives in the regular general course for the degree of Bachelor of Science in Agriculture.

The schedule consists of 30 week-hours carrying 43 semester units and is arranged as follows:

FIRST SEMESTER

COURSES	HOURS	UNITS
Agricultural Education 10	3	3
Agricultural Education 12	3	3
Agricultural Education 13	2	2
Agricultural Education 115		0–5
Agricultural Education 199	1	1
English 2 or	(5)	(5)
English 3	5	5
Prescribed Electives		8–3
Total	14+	22

SECOND SEMESTER

COURSES	HOURS	UNITS
Agricultural Education 11	3	3
Agricultural Education 14	2	2
Agricultural Education 115		1–5
Agricultural Education 199	1	1
English 2 or	5	5
English 3	(5)	(5)
English 4	5	5
Prescribed Electives		4–0
Total	16+	21

The College of Agriculture secured the services of Professor M. A. Foster, of the United States Bureau of Education, to establish this new Department of Agricultural Education. He arrived in the Islands in August, 1928, and started the work of the Department in October, 1928.

Banzon Studio

Department of Agricultural Education, main building

DEPARTMENT OF AGRICULTURAL ENGINEERING

A. L. TEODORO
Assistant Professor of Agricultural Engineering and Acting Head of the Department

ORGANIZATION

The organization of the Department of Agricultural Engineering was a sequel to the appointment in 1912 of Albert George Glodt, C.E., M.E., as associate professor of agricultural engineering. Prior to this period, rural engineering was a subject taught in the Department of Agronomy by Farm Superintendent Harold Cuzner, B.S.

The newly formed Department of Agricultural Engineering included as divisions mathematics, physics, and agricultural engineering proper. Three semesters of elementary algebra, two semesters of plane geometry, and one semester of combined trigonometry and surveying were scheduled for the first three years of the six-year curriculum. The four-year curriculum was arranged to have trigonometry and surveying given during the summer following the second year of study. Two semesters of agricultural engineering were required in the fourth year of the six-year and in the third year of the four-year curriculum.

Although no physics course had been given before Professor Glodt was appointed, the University Catalogue for 1910-1911 described physics as a required course in the fifth year. The subject matter consisted of lectures, demonstrations, and practical experiments with special reference to the application of physical principles on agricultural practices.

The required agricultural engineering course included in its scope surveying and irrigation for the first and second semesters; roads and bridges for the first semester, and buildings and machinery for the second. Special attention was given only to those branches of civil engineering which were closely related to the subject of agriculture. Very little was mentioned on the line of farm motors and farm machinery. The University Catalogue for 1912-1913 mentioned the addition of an advanced course in agricultural engineering which dealt with farm, sugar, and rice machinery.

PERIODS OF DEVELOPMENT

The history of the department so far may be divided into two periods. The first comprises the period between 1910 and 1921, and the second between 1921 and 1929. The first is characterized by objectives which were pursued to develop agricultural engineering along civil engineering lines and the second to develop ideas on the bases of power, machinery, buildings, sanitation, equipment, irrigation, and drainage.

DEVELOPMENT IN MATHEMATICS DIVISION

The names of Harold Cuzner, Sam B. Durham, Leon Sanford Johnston, Anna Laura Davis, N. B. Mendiola, Vicente C. Aldaba, F. O. Santos, and M. A. Roa are identified with the development of the mathematics division. From 1910 to 1918 the teaching of mathematics was given partly by instructors and partly by students assistants. Among those advanced students who were given the full responsibility to handle mathematics classes were Messrs. N. B. Mendiola, L. B. Uichanco, and V. C. Aldaba. From 1918 to 1929, student assistants were replaced by graduate assistants who had shown proficiency in mathematics while still undergraduates. Messrs. Benedicto de las Alas, Eusebio Bataclan, Antonio Reyes, and Nicanor Castillo were among the graduates from the College of Agriculture who were employed in the mathematics division after their graduation. Cecilio Ponco, Bartolome Blanco, Severino Pineda, and Alfonso Hilado were College of Engineering graduates who served as instructors for a year or two in the same division. Mr. Alas is still connected with the Department, holding an instructorship in mathematics.

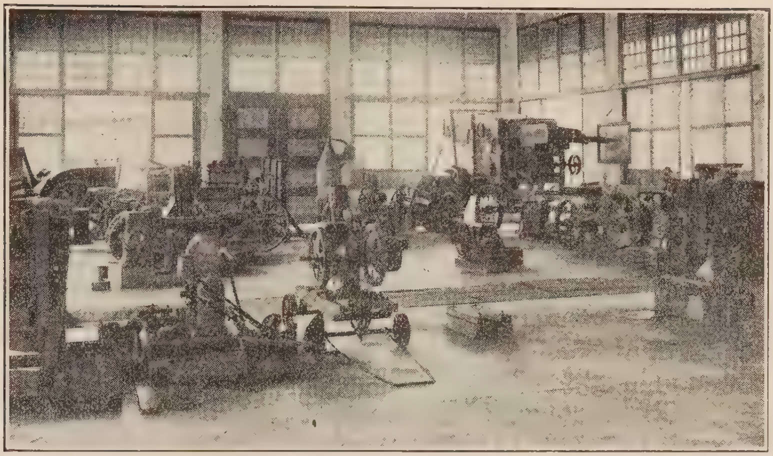
Under the able management of Professor Roa, solid geometry, descriptive geometry, college algebra, analytical geometry, differential calculus, and integral calculus were added to the original list. They were given as required subjects in the Sugar Technology Curriculum, beginning the academic year 1920-1921.

DEVELOPMENT IN PHYSICS DIVISION

Professor Glodt taught physics from 1912 to 1914. From 1914 to 1919 Professor Cuzner gave it with the help of student assistants. In the teaching of the course, special emphasis was given to the subject of mechanics. Heat was lightly touched and electricity, magnetism, sound, and light were not studied at all. No regular laboratory experiments were performed. The laboratory periods were spent in drilling the students in the use of the different formulae and in solving theoretical and practical problems in mechanics.

When Professor Roa was given charge of the course in 1920, laboratory experiments were introduced. The text book was changed from Spinney's Text Book of Physics to Black and Davis' Practical Physics. Electricity, sound, and light were included and the length of time spent in solving problems was shortened.

When the College of Agriculture curriculum was reorganized in 1921, the old physics course was split into six units of secondary school physics and five units of college physics. The secondary school physics was scheduled for the whole year in the second year of the six-year curriculum and was taken concurrently with plane geometry. College physics was scheduled for one semester in the fourth year of the six-year curriculum. It was also made a required subject in the four-year curriculum.



Machine shop, Department of Agricultural Engineering

Eight units of college physics were required in the Sugar Technology Curriculum, instead of the five units which were scheduled for all curricula. The subjects of mechanics, thermo-dynamics, electricity, and light were discussed more fully in this course.

Instructor A. L. Teodoro took charge of the college physics course from 1921 to 1926. Mr. Antonio L. Rocafort taught the secondary school physics from 1922 to the present time. Professor Johnson, Professor Roa, and Doctor Gordon helped in giving the advanced course for a semester or two. Mr. Angel Africa was graduate assistant in the physics division from 1920 to 1924, and Mr. Fidel Reyes from 1925 to 1929.

DEVELOPMENT OF AGRICULTURAL ENGINEERING PROPER

Surveying, mechanical drawing, and planning of buildings constituted the three most important subjects covered in the agricultural engineering course from 1910 to 1921. Lectures on sewage disposal plants, irrigation, and drainage were given as additional topics. The laboratory periods were spent making projection drawings, graphical solution of roof trusses and, at one time, building an irrigation canal along the Molawin Creek.

Professors Glodt and Cuzner carried on this policy from 1912 to 1914 and from 1914 to 1921, respectively. An important requirement which developed into a tradition during the time of Professor Cuzner was the drawing of a term plan consisting of three complete views of a house or of a building with complete specification. On several occasions the graduation of certain seniors was delayed for failure to comply with this requirement.

Courses in farm mechanics, farm gas engines, and farm machinery were introduced by Instructor Teodoro in 1922. Instead of exclusively developing the required course in the line of civil engineering, one semester was devoted to the study of farm power and farm machinery, and another semester to irrigation and drainage. Later, changes in the course were made to devote the entire year to farm mechanics, farm power, and farm machinery only, and making irrigation and drainage elective. This arrangement was made after it was found that the soils division and the farm management division, both of the Agronomy Department, were respectively including in their required courses discussion on irrigation and drainage and actual work and operation of tractors as motive power. This change made it possible to avoid duplication of courses along this line of study.

The work which Instructor Teodoro started was encouraged by Professor C. P. Johnson when the latter came as professor and head of the Department in 1923. Although originally appointed as professor of agricultural engineering, Professor Johnson did not teach any agricultural engineering courses, except the elective subject of drainage. Professor A. L. Teodoro, assisted by graduate assistants Carreon and Nacion, taught all the engine and machinery courses from 1924 to 1926.

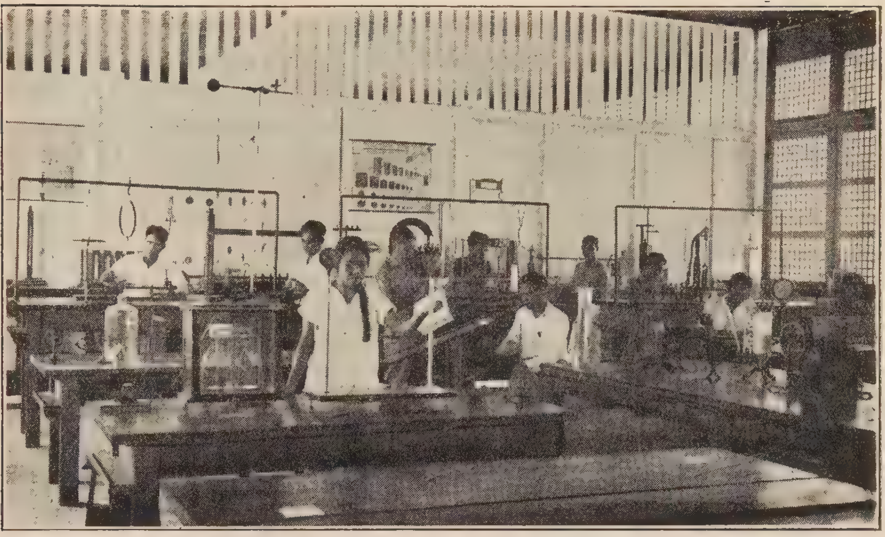
Laboratory work in connection with irrigation and drainage was also required in 1922. The laboratory work comprised building of different kinds of weirs used for irrigation, measurement of flow of water in creeks and rivers, pumping of water for irrigation, measurement of irrigation water actually used for lowland rice in the College, making trips to irrigation districts of Calauan and Calamba, and preparing topographic surveys and maps. Dr. Alexander Gordon took charge of this course upon his return from the United States in 1927.

The newly approved course of studies for the College of Agriculture beginning 1929 includes the following agricultural engineering courses: farm mechanics and gas engines; farm motor and farm machinery; irrigation and drainage; concrete; advanced surveying; farm building; farm sanitation; sewers and sewerage; advanced farm machinery and farm motors; advanced irrigation and drainage; and irrigation laws. Doctors Teodoro and Gordon, assisted by Instructors Ongsansoy and Ferrer, are scheduled to give these courses.

Professor Irving Leonard and Instructor Felix Maramba had their original appointments in agricultural engineering. Although Professor Leonard was appointed temporary professor of agricultural engineering, his work for a period of six months was devoted to the teaching of mathematics. Instructor Maramba took charge of the classes left by Professor Teodoro when the latter took advanced work in the United States from 1926 to 1928.

DEVELOPMENT OF FARM EXPERIENCE COURSES

Carpentry and blacksmithing were scheduled beginning the academic year 1919-1920. These courses were required, but no formal credits were given. The elements of woodworking and of blacksmithing were included in the course. Messrs. Bondoc and Vidal have taught the two courses since 1919.



A class in physics, Department of Agricultural Engineering

INVESTIGATION AND RESEARCH

Investigational work on the strength of bamboo, on the length of usefulness of fences, and on cassava starch producing machines were carried on under the direct supervision of Professors Harold Cuzner from 1915 to 1921. Due to the extracurricular work assigned to Professors Glodt and Cuzner, very little time was devoted to research. Professor Glodt's transfer from the position of civil and mechanical engineer of the Bureau of Public Works to associate professorship in the College of Agriculture was made on condition that he supervise the completion of the irrigation system and power plant and manage all the construction work in the College. From 1912 to 1914, Professor Glodt devoted one-half of each school day to this work.

When Professor Glodt resigned in 1914, Professor Cuzner was given the responsibility laid down by Professor Glodt. All the construction work in the College was carried on under his supervision and under the management of Mr. Joaquin Ruiz de Arana. More time could undoubtedly have been devoted to research by Professor Cuzner if it had not been for this extracurricular work. When Professor Cuzner's transfer to the School of Forestry was made in 1921 and Professor Leonard assumed the headship of the Agricultural Engineering Department, all the construction work was given to Mr. Arana. A Service Division was then unofficially established to handle transportation, building construction, maintenance of property, and water and light service. From 1922 to the present this division, headed by Farm Engineer Joaquin Ruiz de Arana, took charge of service work in coöperation with the Department of Agricultural Engineering.

Under the supervision of Professor Teodoro, investigational work on sewage disposal plant, comparative study of cost data on using animals and mechanical power for the farm, drafts of different kinds of plows, design and construction of home-made rice thresher, and preliminary studies on the amount of irrigation water actually used by rice in Calauan and in Calamba were carried on from 1921 to 1926. From 1926 to 1929 Dr. Alexander Gordon made studies on several types of gravity gates and on the strength of cement concrete and mortars.

THE ₱10,000 SPECIAL APPROPRIATION FUND

Representatives Confesor and Festin published in the *Philippines Herald* sometime in August, 1924, a criticism of the courses in agricultural engineering in the College. The criticism was based on the fact that no practical work on tractors, and on the use of more modern farm machinery were given. An invitation was sent to these representatives to visit the Department. When they returned to Manila, Mr. Confesor fathered a bill setting aside ₱10,000 as special appropriation for the Department of Agricultural Engineering for 1925. With this amount the Department was able to purchase two tractors, one Ford chassis, four small gas engines, one big gas engine, one small rice thresher, five types of pumps, one kilowatt generator, one complete 600-watt Delco plant, one gang plow, three small walking plows, and about one thousand pesos worth of supplies. The blacksmithing and carpentry divisions were provided from this fund with forges, hammers, planes, saws, and many other carpentry tools. About ₱400.00 worth of agricultural engineering books and journals were also purchased out of this fund.

DEPARTMENT OF AGRONOMY

NEMESIO B. MENDIOLA
Professor of Agronomy and Head of the Department

THE DEPARTMENT IN RETROSPECT

The twentieth anniversary of the College of Agriculture is also the twentieth birthyear of its Agronomy Department; for, when the institution held its first classes on June 14, 1909, major work was offered in agronomy only. Thus we find that the first graduates of the College, Manuel L. Roxas, Clodoaldo Tempongko, and José Zamora, all majored in agronomy. However, the formal organization and naming of the Department did not occur until the second year of the existence of the College of Agriculture. It was organized by the first dean, Dr. Edwin Bingham Copeland, who also was the first Department head. With him in the agronomy staff were Professor Harold Cuzner as farm superintendent and Mr. Mariano Manas Cruz as instructor. All of these men are still living, Dean Copeland being connected at present with the Department of Botany of the University of California, Professor Cuzner with the Bureau and the School of Forestry of the Philippines, and Mr. Manas Cruz, with the Bureau of Agriculture.

The earliest agronomy courses offered were listed as "(1) the cereals (especially cane, rice and maize), (2) the coconut and fiber plants, (3) tobacco and horticulture (coffee, cacao, and citrus, budding and grafting), and (4) thesis." In later years this list did not suffer many fundamental changes, the courses having been merely split in some cases and expanded in others. For example, sugar cane was separated from the "cereals" course, and tobacco, from the course "tobacco and horticulture." Also, horticulture was split into pomology, olericulture and floriculture, and coffee and cacao, organized into a separate course now known as coffee, cacao, and spices.

During the twenty years of its existence, the Department has had four different heads. Dean Copeland became the head in June, 1909; Professor Baker, in August, 1912; Professor Higgins, in December, 1920; and the writer in August, 1928.

As Doctor Copeland is a plant physiologist, it was to be expected that, during his incumbency at least, the botanical phases of our agronomy courses would be emphasized. That was what happened in fact. It was Doctor Copeland's policy to consider botany rather than chemistry as the basis of agronomy. The best example of an agronomy course in which botany was greatly emphasized was the first Agronomy 2 course, which was taught by Doctor Copeland himself. Each student who took it had to determine, among other things, the rate of growth of twenty or thirty coconut trees, and on the day the trees were to be measured, he had to climb the trees and make the measurements whether the day was bright and fair or there was a typhoon raging. It is curious to see that this same course is still taught at the present moment by our plant physiologist, so great was the effect of the policy of the first dean, and such is the importance placed on plant physiology as the basis of our coconut and fiber work. Many theses which have been turned out by the Agronomy Department were more or less on plant physiology subjects.

Professor Baker was a tropical agronomist, although he was more than that, and in his time work in most lines of Philippine agronomy was started or improved. The majority of those who are at present holding important agronomical and horticultural positions in the Philippine Government received inspiration and early training in agronomy from Professor Baker.

Professor Higgins, now in charge of the Plant Introduction Gardens of the Panama Canal Zone, is a pomologist and, during his stay in this College as professor and head of the Department of Agronomy, the interest in pomology, already created by Professor Baker, was kept alive. Our present pomologist received his early training at Professor Higgins' hands. Being a horticulturist, it was quite natural for Professor Higgins to see that emphasis was laid on horticulture and he will be remembered in the future as the Agronomy Department head who insisted upon calling the department the Department of Agronomy and Horticulture. It was also he who thought of calling it, "Department of Phytotechny and Farm Management." Under Professor Higgins' incumbency a small concrete building was erected to provide a place where the Department and the students could perform their operations of seed sowing, budding, grafting, and other exercises in horticulture even during rainy days.

THE DEPARTMENT AT PRESENT

In many respects, this is the largest department of the College—in personnel, in number of students, in number of buildings, in land, in operating expenses, as well as in other minor points. It offers about thirty courses covering all important crops of the Philippines well adapted to the diversified nature of our national agriculture. Its staff now consists of two full professors, one assistant professor, six instructors, and eleven assistant instructors. It has a large number of annual cultures in constant progress which, together with permanent plantings, including orchards, ornamental and miscellaneous plants of economic importance, occupy most of the three hundred sixty-six hectares of land of the College not occupied by buildings.

Housed in the first year of its life in part of one building of mixed material, now the agronomy plant can boast of five concrete buildings of permanent character and one of wood and light materials. A large and strong concrete bridge recently completed connects its building zone with

Agronomy Main Building

that of the farms. An explanation of the early plans for the buildings and their use at present will serve to indicate how much the Department has grown and also the inadequacy of its building equipment at the present time. The first building to house the Department of Agronomy is the Old College Building, which does not now belong to this department, but is occupied by the Department of English and Modern Languages, by the Extension Division and by the Post Office. The second house built for agronomy is what we have come to call the Seed House, because it was built purposely to house the harvests from the farms and all the operations connected with them, such as threshing, winnowing, drying, storing and seed testing. Just outside the building there were built cement floors for seed drying. About ten years after these floors were laid, the number of agronomy students had so increased that a part of the drying floors had to be roofed and used as a lecture hall and the greater part of the building proper utilized as student lecture and laboratory rooms. The agronomy building erected next is a small concrete structure which is better known as the Tobacco House. This building was constructed not merely to provide a place for the simple operations of stringing, drying, curing, fermenting, classifying, baling, etc., of tobacco leaves, but especially to have a room where the effects of these processes on our tobacco can be studied under controlled conditions of temperature, light, wind and humidity, with a view to their improvement. However, the uses of the Tobacco House have outgrown the original object of its construction, for it now houses not only our laboratory and *camarin* work with tobacco but also similar work with coffee and cacao. A visitor will find it at present a combination storage house, lecture room, and laboratory, containing bales and piles of tobacco leaves, coffee pulping and grinding machines, coffee and cacao products, as well as smaller articles used in laboratory work. Tobacco House was followed by the Main Agronomy Building. One third of the floor space of this building has been used solely as a lecture room, with the result that other activities of the Department not housed elsewhere have to be crowded into the remaining space. At present, besides this large lecture room, the building provides space for the central agronomy administrative office, and the work of the divisions of plant breeding, sugar cane, fiber and oil, floriculture and landscape gardening, and the business office of *The Philippine Agriculturist.* The next agronomy construction is the so called Nursery Building. Originally built to serve as a plant propagation house, it was later forced to accommodate the office, lecture room and laboratory of our pomologist, who had previously been using a portion of the Main Agronomy Building for these purposes. This was followed by the Farm Management Building which was originally intended to serve as a store house for tools and machines that had previously been kept in a bamboo and nipa shed. However, it is more appropriate to call it Farm Management Building for it also houses the office of those in direct charge of this work. Besides this, it became a seed *bodega* and seed harvest laboratory when the Seed House was partly converted into lecture, laboratory and office rooms. The last agronomy building erected was the Soils Building, which houses the offices, laboratories, lecture room, and storehouse of our soils division, besides most of the College photographic work.

As organized at present, the Department of Agronomy includes several main lines of work, such as general farm crops, soils, farm management, plant breeding, pomology, vegetable growing and landscape and ornamental gardening,—lines which in much larger colleges of agriculture constitute large separate departments. One of the causes responsible for the present organization was the policy of the first dean of the College. Three attempts have been made to divide the Agronomy Department into several independent units, but these attempts have failed. One reason for this failure is the idea underlying the policy just mentioned. Another is the fact that the activities of its various lines and ramifications have become so interlocked that it would be difficult to simplify it.

POLICIES UNDERLYING ORGANIZATION

A few words about policies of organization. In his report on the work of the College of Agriculture, published in the *Philippine Agriculturist and Forester* (1916) **5:** 1–31, Dean Copeland wrote:

> The Department of Agronomy, according to our organization, includes all agricultural work with plants. In most institutions, this field is broken into two or more, Agronomy retaining only the field crops, while the orchard crops fall to the Department of Horticulture. In many places the division goes much further than this, so that there are separate departments for garden crops, for ornamental plants, for such crops as sugar which require particular service from other departments (in this case, chemistry). In my opinion the simplest practical organization is both cheapest and most efficient. *It has, therefore, always been the policy of this College to have as few independent departments as possible. In this respect, the Bureau of Agriculture has followed our example, and abolished its former Division of Horticulture.*

Seed and Harvest Laboratory

Records in the Department of Agronomy show that it was the policy of both Dean Baker and Professor J. E. Higgins, the third head of the Department, to work out during a period of five years, beginning with 1922, the division of the department into seventeen subdepartments. This policy was embodied in a plan of organization which was presented before the President's Intramural Committee on University Survey. Evidently this Committee recommended in 1921 the splitting of the Agronomy Department into Department of Agronomy and Department of Horticulture. Dean Baker disapproved this recommendation and had the support of his faculty and the University Council. The plan was worded as follows:

> We look forward to a sub-department grouping something as follows. It will be clear that each head includes work sufficient for several good men if we do it as thoroughly and on as comprehensive and technical a basis as is being done elsewhere in the best institutions, as the needs of this country urgently demand.
>
> 1. General Principles. Teaching and elementary practice.
> 2. Farm Management and Operation. Certain features of exceedingly important teaching must be done under this head. Even more important is the general carrying of operation which in itself must involve the most important function under any subhead, that of securing complete and fair culture service for all sub-departments, and hence promote effective coöperation in all experimental work.
> 3. Plant Breeding (Genetics). The real effectiveness of this highly important work will to a great extent depend upon constant and close cooperation with the other sub-departments. Its special influence should be constantly felt in coördination of all work in the department.
> 4. Fibers and Textiles. In constant coöperation with Rural Engineering and Plant Physiology.
> 5. Sugar Culture. In coöperation with Sugar Technology.
> 6. Oils and Oil-producers (Coconuts, Sesame, Lumbang, etc.). In coöperation with Chemistry.
> 7. Rice and Other Cereals (Corn, Sorghums, Millets, etc.).
> 8. Field Root Crops and Starch-producers (Cassava, Camotes, etc.).
> 9. Forages and Pastures. In coöperation with Animal Husbandry and Chemistry.
> 10. Tobacco.
> 11. Legumes and Green Manures.

12. Rubber, Gum, Resin and Alcohol-producing plants. In coöperation with Chemistry.
13. Fruits and Nuts (Pomology).
14. Coffee, Tea, Cacao, and Spices.
15. Vegetable Production (Olericulture).
16. Floriculture and Landscape Gardening.
17. Soil Technology.

It will be noted that none of these groups can be isolated, but that all must perforce overlap in operation as well as in various minor features of treatment and this means that any real future success in this department will depend upon one thing more than any other—the securing of a harmoniously coöperative working force. The future is holding out tremendous possibilities to us in this department. The question now remains if we are big enough with sufficient far-sightedness—vision to develop these possibilities.

In September, 1928, the present and third permanent dean, Dean Gonzalez, commenting on a proposed division of the department, expressed in the following words that it was not yet time to carry it out: "The present stage of development of the College of Agriculture hardly warrants the division of its most important department . . ."

It seems very clear then that the Department of Agronomy, while the largest department of the College, really has not been nurtured sufficiently to grow and beget a new generation of departments as it should. This condition may certainly be brought about by greater financial support and a larger quota of fellows and pensionados for higher technical and specialized training. In no other department of the College of Agriculture is it more necessary than in the Department of Agronomy, to have a constant and liberal supply of native technical agriculturists with foreign training and native experience in their lines of work, especially in a university like ours where the remuneration is not sufficiently high to hold its men in competition with outside employers.

In the Agronomy Department many men have come and gone. Professors Copeland, Baker, Higgins and Cuzner, Messrs. Manas Cruz, Rundles, Cocanouer and Elayda, Doctors Vibar and Aldaba, Messrs. Raymundo, Rodrigo, and a number of lower rank, have each contributed in some form

Soils Building

Agronomy Nursery

or another to the building of the Department. Some of them have been its acting heads.

Without going into the reasons for their separation from the Department, it may be said that their leaving serves to emphasize the necessity of training more men for agronomy service and inducing those who have not gone out to stay where they are.

American tropical agronomists are few and far between. The deaths of Professor Baker and Professor Earle have made the gaps much wider. It seems out of the question to bring in German or Dutch tropical agronomists. It remains for us to increase the agronomy quota of those to be given the privilege of training not only or necessarily in the United States of America, but also in tropical countries where scientific agriculture has done wonders. We cannot run the Department of Agronomy properly with men who are not specialists in their respective assignments, for, as Dean Baker once wrote, "The existence of a single man in any chair in an agricultural college, who is not a thorough master of his subject, and not willing or able to live up to the highest ideals and purposes of such a college, may seriously vitiate and cripple the work of the whole institution." One of the policies then of the Department is to raise and maintain a high standard of personnel. Three of its staff members are now abroad working for their doctorate. One or two partial pensionados of the University of the Philippines are expected to join the Agronomy staff when they return.

OUTSTANDING EVENTS IN THE DEVELOPMENT OF THE DEPARTMENT

The most important events in the life of the Agronomy Department are: (1) its foundation and organization by Dean Copeland in 1909, (2) the assumption by Professor Baker of the position of professor and head of the Department of Agronomy in 1912, (3) the passage in 1918 of Act numbered 2730 of the Philippine Legislature providing for the establishment of an experiment station at the College of Agriculture and (4) the permission given by the Board of Regents to the Agronomy Department to keep a revolving fund beginning with the year 1926.

While to former Dean Copeland belongs the honor of establishing the Department of Agronomy, the credit for its rapid growth and progress in subsequent years belongs to the late Professor and Dean Baker. As soon as he joined the College staff, his dynamic influence upon the department was immediately felt. Dean Baker came rich in tropical experience gathered in the service of governments of various countries. When he took up his work here at Los Baños, he put all his heart and soul in it, and gave it all the benefit of his experience. Cultures were enlarged and made more varied, old courses were expanded and new ones added. By his own example, students were encouraged to do more work in the field and thus were enabled to gain more lasting knowledge of actual farming. The beginning of an ornamental and landscape garden was laid out and what is very important, a campaign to get an experiment station for the College of Agriculture was initiated, a campaign in which he enlisted the aid of all important elements, professors, alumni, students, and friends outside the College.

This campaign resulted not only in greater appropriations for the Agronomy Department and the College, but in the passage of the Act sponsored by the Honorable Representative Guillermo F. Pablo of Zambales, Act No. 2730 which provided for the establishment of the College Experiment Station. By virtue of this law, the Agronomy Department was able to enlarge its sets of farm implements and laboratory equipment, to add not less than one hundred hectares of land to its farm, and to expand (generally) its various cultures. Unfortunately the Act did not provide for operating expenses of the experiment station in subsequent years, hence the Department has had to depend on its regular funds in working this land. Dean Baker, seeing the improbability of the provision of a special fund by the Philippine Legislature for the yearly expenses of the experiment station, next started a campaign to secure the federal aid usually given to land-grant colleges in the United States and its territories. The campaign was partly successful for it overcame the prejudice of many of our responsible men in and outside the government against asking the United States for any such aid. Unfortunately Dean Baker died without seeing the final fruits of his labor. Before his demise, however, he was able to secure from the Board of Regents of the University permission for the Department of Agronomy to operate a revolving fund with the receipts from sales of farm products. The need for and advantages of this fund had been presented to the proper authorities several times during the two years before the permission was granted. The fund has been a great relief to the members of the Department as it has served to supplement the funds generally appropriated for farm use. The agronomy revolving fund has now been in operation for only four years.

Sun Studio

Professor Harold Cuzner

RESULTS ACCOMPLISHED

From the national standpoint, the most important products of the Department of Agronomy are the native agronomists and horticulturists it has trained. These agronomists and horticulturists are found in various branches of the government, in private agricultural concerns and in different lines of work. In the Bureau of Agriculture, for example, we find men occupying important positions who majored in agronomy in this College. Some of these are the present assistant director; the chief of the Plant Pests Control Division; the assistant chief of the Extension Division; the horticulturist; the tobacco specialist in charge of the Bureau's tobacco projects and the Ilagan Tobacco Station at Ilagan, Isabela Province; the acting superintendent of the Tobacco Station in Sarunayan, Cotabato; the superintendent of the Rice Sub-Station in Rosales, Pangasinan; the superintendent of the Lamao Experiment Station at Lamao, Bataan; the superintendent of the Tanauan Citrus Experiment Station, Tanauan, Batangas; the superintendent of the Guinobatan Abaca Experiment Station at Guinobatan, Albay; the acting superintendent of the Maridagao Rubber Experiment Station at Maridagao, Cotabato; and several others. Outside the government service there are college graduates who are conspicuously successful in agronomy work.

As is to be expected, the graduates of the College who majored in agronomy number more than those in any other department. Of the more than six hundred graduates which the College has turned out about one half majored in agronomy and horticulture. Along the line of investigation and research, the agronomy staff has been very active and in twenty years' time has turned out a large mass of technical and scientific data bearing on

Philippine and tropical agriculture. A glance at the list of published contributions of the College will give a good idea of this accomplishment. To these should be added about three hundred separate technical papers which constitute the graduating theses of those students who majored in the Department of Agronomy. These reports cover every important crop of the Philippines and deal with the various phases of the art of crop growing. Only a very small portion of this mass of data has been published.

At present the Department of Agronomy has about sixty hectares of land in lowland rice, twenty in upland rice and in maize, twenty-five in sugar cane, twenty in maize, seven in different varieties of coffee, several hectares in fruit trees, several in forage and legumes of various kinds and uses and some in miscellaneous plantings. Did the Department not have these very important fields for the training of agricultural students, its work along this line would be very ineffective. As it is, these plantations not only serve as practice grounds for the students of the College of Agriculture, but they have also served the Philippines as a large seed farm and nursery from which annually much seed and propagating materials have found their way to the farms in all parts of the Philippines.

In addition to the cultures representing the crops of the Philippines, the Department is operating a kind of an economic botanical garden which it has been building for the last twenty years. It has been doing this by introducing desirable economic species from different parts of the world, mostly of the tropics, testing and acclimatizing them here and propagating the most promising ones. The accession books of the Department show that we have introduced from different parts of the Philippines and of the world no less than 20,000 separate samples of seeds and other propagating materials for local trials. The potential value of these collections to the country can be realized if it is recalled that some of the most important crops or plant industries in the tropics have started from very meager and unimportant cultures. Already our stock cultures of alligator pears (avocado) and caimito, have become sources of propagating materials for what are bound to be important fruit growing industries of the Philippines. Our supply of seedlings of these two plant immigrants has not been able to keep pace with the demand for them. One can never tell when any of the species in our botanical garden might become useful. For example, we have in our arboretum a number of bearing plants of *Hydnocarpus alcalae*, a source of chaulmoogra oil. For a long time, nobody used them. Now we are supplying the Bureau of Science with seeds of this plant for important investigations. There must be somewhere in the archives of the University and the Philippine Government records of an attempt made by the late Dean Baker to have this garden recognized and designated as the Philippine Government Botanic Gardens. If it had been recognized as such by similar institutions the world over, tremendous advantage would have accrued to the College of Agriculture and the University from the scientific standpoint;

Tobacco House, Department of Agronomy

there would have been greater opportunities for exchange of plants and for obtaining publications. It should be stated here that the reservation on Mt. Maquiling now known as the Maquiling National Botanic Gardens is a different thing from the botanical garden which is a part of the College of Agriculture and under the Department of Agronomy. This College garden should be recognized as the College of Agriculture Economic Botanical Garden.

Lack of space forbids further enumeration of the accomplishments of the Department of Agronomy. Suffice it to say that it has amply justified its existence.

DEPARTMENT OF ANIMAL HUSBANDRY

VALENTE VILLEGAS

Assistant Professor of Animal Husbandry and Assistant Head of the Department

ORGANIZATION, INSTRUCTION, AND PERSONNEL

At the time the College of Agriculture first opened its doors on June 14, 1909, animal husbandry was one of its required courses of study. The following year, when the College organization was taking a more definite form, animal husbandry was recognized as one of the major departments.

The first course in animal husbandry offered at this institution, which was required of all agricultural students, was A. H. 1. The course was described as consisting of three parts: "(1) The breeds of live stock; the leading breeds of horses, cattle, sheep, swine, and poultry are studied as to their origin, development, adaptability and characteristics. Practical work consists of score card and comparative judging. (2) The principles of animal breeding: a study of the facts and principles of greatest importance, including heredity, variation, etc. (3) Live stock management: a study of the general care of live stock, with special attention to the care of young animals and breeding stock, the value of proper feeding and the recognition and prevention of contagious diseases."

The following year, 1910, two elective courses were added: A. H. 2a, diseases, and A. H. 2b, feeds and feeding.

In 1912, courses A. H. 2a and A. H. 2b were abolished and instead A. H. 2, also an elective, was offered. The latter course is described as "a study of the breeds of live stock with special attention to judging the native pony, the carabao and cattle." It also included "The study of feeds and feeding, the composition of the animal body, digestion, and the related functions, and the composition of feeds and the compounding of rations."

In 1917, A. H. 2 was changed to include principles of animal nutrition and breeding and animal diseases.

The year 1921 saw the creation of the first animal husbandry curriculum in the College. Provision was made for various branches of animal husbandry treated as specialized lines. The different courses listed in that year were as follows:

A. H. 1.—General principles, 10 units.
A. H. 2.—Principles of animal nutrition, 5 units.
A. H. 3.—Animal breeding, 3 units.
A. H. 4.—Breeds of live stock and pedigrees, 3 units.
A. H. 5.—Anatomy, 3 units.

A. H. 6.—Common diseases of animals, 3 units.
A. H. 7.—Poultry husbandry, 3 units.
A. H. 8.—Dairy husbandry and manufactures, 3 units.
A. H. 10.—Thesis, 10 units.
A. H. 11.—Swine husbandry, 3 units.
A. H. 12.—Herd management, 5 units.
A. H. 109.—Investigation, 3 to 5 units.

Besides A. H. 1, A. H. 2 and A. H. 3 were also required of all students taking the animal husbandry curriculum. The rest of the courses were elective, excepting A. H. 10 (thesis) which was submitted by students majoring in animal husbandry before graduation.

Besides other minor changes which took place in 1922, two new courses were introduced, namely, A. H. 199, seminar in animal industry, and A. H. 300, master's thesis in animal husbandry.

In 1925, A. H. 105, horse husbandry, was included among the elective courses of the Department. Also, the first extension course in poultry raising was given in the summer of that year.

The latest development in animal husbandry courses took place on January 19, 1929, when the new curriculum of the College was approved by the University Council. The courses now in force are as follows:

A. H. 1.—General principles of animal husbandry, 3 units.
A. H. 2.—Live stock judging and management, 4 units.
A. H. 3.—Principles of animal nutrition, 3 units.
A. H. 4.—Animal breeding, 3 units.
A. H. 5.—Pedigrees, 3 units.
A. H. 99.—Special problems, 1 to 6 units.
A. H. 100.—Undergraduate thesis, 10 units.
A. H. 101.—Poultry husbandry, 5 units.
A. H. 102.—Swine husbandry, 5 units.
A. H. 103.—Cattle husbandry, 5 units.
A. H. 104.—Dairy husbandry, 5 units.
A. H. 105.—Horse husbandry, 5 units.
A. H. 199.—Seminar in animal husbandry, 2 units.
A. H. 300.—Master's thesis, 10 units.
Elementary poultry raising extension course.

To Professor Sam B. Durham belongs the credit of starting collegiate instruction in animal husbandry in the Philippines. Shortly after the founding of the College, Mr. Durham was appointed instructor in animal husbandry on August 17, 1909. On November 14, 1914, as assistant professor, he left the College after more than five years of service. Professor Durham's task was beset with great difficulties and only a man of his determination and stamina could have withstood the trying conditions under which a teacher without proper facilities for the conduct of animal husbandry classes was working. During these trying formative years the names

The only silo in use in the Philippines; in the Department of Animal Husbandry

The Animal Husbandry Bridge, constructed out of income of the Department of students and graduate assistants who aided Professor Durham are worthy of record. The first graduate assistant appointed in animal husbandry was B. M. Gonzalez. As student assistants, Ludovico Hidrosollo, now Regent of the University of the Philippines and Director of the Bureau of Non-Christian Tribes, Mariano B. Raymundo, Florentino F. Cruz, Atanacio B. Catambay, Dionisio Pastorfide, Amando Laparan, and Alfredo Adriano worked at different times under Professor Durham. Mr. Raymundo's unusual ability in things practical was a big asset in that early period of the Department.

Although Professor Durham was the pioneer and founder, Dr. B. M. Gonzalez was in reality the builder and organizer of this Department. Under Doctor Gonzalez, the Department made rapid progress. With a good academic preparation behind him and under the more liberal support of a growing institution which was fast gaining the confidence of the people, progress was inevitable. All that was necessary was initiative and the execution of plans which Doctor Gonzalez had in mind.

During his administration, the department has reached its greatest growth in personnel, equipment and research work. The foundation stock of big animals was acquired during this period. He alone is responsible for the introduction and initial work of improvement of the Improved Strain of Cantonese chickens at this College, for the introduction of the Nagoya breed of poultry from Japan, and for creating the Berk-jala swine. He started the dairy project and established the ice plant. The Animal Husbandry Revolving Fund has been run in a most efficient way. One outstanding feature of his policy, which has lasting influence, is the creation of animal breeds arising from the amalgamation of the good points of imported and native animals. From the sad experience of past importations of foreign animals which would not survive under tropical conditions, Doctor Gonzalez saw that the solution lay in getting the right animals for the Islands by improving productive ability through the use of foreign breeds and their adaptability and resistance to local conditions united with native blood. This theory is finding verification in the production of the Berk-jala swine, and in our grading work with cattle, goats, and poultry.

Owing to the fact that Dean Gonzalez is now devoting most of his time to the administration of the College, the burden of carrying on the work of the Department has been largely delegated to the following personnel: (1) Animal nutrition, horses, sheep, and goats—Dr. V. Villegas. (2) Poultry—Dr. F. M. Fronda and Pedro S. Paje. (3) Swine—Dr. M. Mondoñedo. (4) Beef cattle and animal genetics—Dr. Miguel Manresa. (5) Dairy husbandry and manufactures—Mr. F. B. Sarao. (6) Supervision of labor and herds—Mr. J. P. Esguerra. (7) Accounts—Mr. A. Taleon.

PROJECTS

Dairy

The dairy tops the list in progress made by any project since its creation. During the last five years the returns were from ₱2,392 in 1924 to to ₱3,863 in 1928.

Breeding work with cattle and water buffaloes is being carried out with a view to producing dairy animals adapted to Philippine conditions. Also, cheese and butter making receive attention as part of the dairy work.

Horses

The horse being the basic animal in live stock judging, naturally it was the first animal to receive attention in animal husbandry work. At the beginning of the classes in this Department, the only animal for laboratory work in livestock judging was a borrowed horse which had to be tied to a tree around which the students gathered and wrote down their points on score cards.

As a project, the Department's aim in horse work is to develop a general utility pony which will be an improvement over the native stock and its defects, particularly as to size, style, symmetry, underpinning, and development of the hind quarters. To attain this end, Arabian blood over selected native animals has been used. Besides the points indicated above the Arabian blood is expected to strengthen the stamina of the progeny.

The first horse to be acquired was former Dean E. B. Copeland's horse, which was donated to the Department in September, 1917. This was followed by the purchase of selected horses from Lipa, Batangas, on June 1, 1918, consisting of one stallion, Sultan, and two mares. Next came the late Dean Baker's horse in 1921, also a donation. Another stallion was received at the College in 1922, from the College of Medicine, University of the Philippines. On March 21, 1924, the first Arabian-Native stallion, Hassan, was purchased to head the College stud. Mr. John Dumas, formerly of Calauan, Laguna, presented to the Department one stallion and one mare on January 13, 1926. With these animals came a filly by purchase. On February 19, 1927, a valuable mare, probably an Arabian grade, was acquired from Lipa, Batangas. President Rafael Palma of our University donated to the Department two stallions, with characteristics of American grades. Of these, Fighting Blood is the better animal and is being used for breeding purposes. This animal arrived at the Department on January 4, 1929, while the other came on October 12, 1927. The Department has at present 17 horses.

Cattle

Range Cattle.—To meet the needs of ranchmen for a type of cattle which will be best adapted to the range and resistant against diseases, and yet one which will possess the size, conformation, and disposition that will give the most service (in work) on the farm, with a comparatively large amount of dressed carcass on the block, is the purpose of breeding work with range cattle. In the course of this investigation, various crosses and grades of cattle have been produced which find good market among ranch owners pursuing constructive breeding work with their animals. A number of them are also being turned out as work stock for the Departments of Animal Husbandry and Agronomy.

Three basic breeds of cattle are used in breeding work, namely, the Native, Nellore, and Hereford breeds.

The Native cattle are well known for their good disposition and efficiency as work animals. Their fecundity is also of common observation. These characteristics are borne in mind in using them for the production of an all-round Philippine ox. There were four cows and one female calf of this breed bought in Los Baños, Laguna, on November 19, 1919. On July 18, 1923, one cow with her female calf were secured from Lipa, Batangas. The need of a bull was evident later in connection with the work and on February 9, 1929, one was acquired in Los Baños.

The first Nellore cattle bought by the Department consisted of five cows which arrived at the College on November 8, 1918. They had been originally imported from India by the Department of Agriculture and Natural Resources. On January 24, 1929, two more cows of the same breed were purchased from the Tunasan Estate, Laguna. Seven bulls have been sold for breeding purposes. At present the total number of Nellore cattle is 18, headed by Madras, a first prize winner in the Livestock Show of the 1927 Manila Carnival.

The biggest importation of Hereford cattle from Texas, U. S. A., in 1920, was made by the Bureau of Non-Christian Tribes, from which the College Herefords consisting of one bull, Bonnie Lad 15th, and four cows, were obtained. The College animals arrived from Mindanao on October 22, 1920. There are now altogether six animals in the herd. Three bulls born in the Department have been sold for breeding purposes. Out of the original stock, Bonnie Lad 15th and one cow have already died. Bonnie Lad 15th died on January 14, 1928, after about seven years of continuous heavy breeding service.

The Herefords were introduced into the Islands for the purpose of improving the Nellore-Native grades in size and beefiness. Although this breed withstands best the rigors of winter in temperate regions, when transplanted into a tropical land, like the Philippines, the animals degenerate and finally perish. It may be safely said that the College Herefords constitute the only herd that acquit themselves creditably under Philippine conditions. Even then all progeny born here become stunted and the herd as a whole has required more care than either the Native or Nellore cattle, or their grades. It is, however, noteworthy that the fertility of the bulls of these cattle remains unaffected even in the case of old, rundown individuals.

From the year when the College was opened, the Department exercised supervision over the supply and care of work animals used by both Departments of Animal Husbandry and Agronomy. From time to time native work bullocks were purchased from Batangas, and Indo-Chinese work steers from Manila. When these animals were no longer giving satisfactory service, they were slaughtered for meat.

From the large number of grades produced from breeding experiments, six grade bulls have been disposed of for improvement work on private ranches. At present the Department has a total of seventy-seven head of native and grade cattle.

Dairy cattle. On August 1, 1928, two Holstein cows and two bulls were purchased for the Department. This experiment was made to determine the feasibility of keeping these animals under Philippine conditions. So far, both in yield of milk and length of lactation, the results have been very satisfactory. The calves likewise have made uninterrupted growth. One of the cows having been bred to a Nellore bull is expected to calve soon. The line of breeding followed with these animals is to mate Nellore cattle with the Holstein in the expectation that the progeny will carry the hardiness and resistance of the Nellore parent and the dairy value of the Holstein blood.

A BLUE RIBBON, MANILA CARNIVAL
Produced at the Department of Animal Husbandry

Water buffaloes

The Department maintains two breeds of water buffaloes: the native carabao and the Indian buffalo. Animals possessing both strains are interbred to produce a type which will give high production of milk and relatively long period of lactation. Observations are, at the same time, being carried on to determine the comparative adaptability, growth, working efficiency, reproductive capacity, and other features of the two breeds and their crosses and grades.

The foundation stock of native carabaos, consisting of five cows and two work steers, came from Zambales to the College on January 13, 1917. On November 3, 1918, one Indo-Chinese bull was added to the Department's carabao herd. At this time the herd has reached a total of 39 head.

The original three Indian buffalo cows and one bull came to the College on November 8, 1918. They were bought from the Department of Agriculture and Natural Resources which made direct importation of these animals from India. Four bulls and one cow have been sold for breeding purposes. At the present time there are eleven head in the herd.

Goats and sheep

The requirements and mode of living being similar in these two classes of farm animals, they are grouped together in their management.

The purpose in sheep raising at the Department is to produce a mutton type adapted to the Islands. The Indian breed is selected as the basic stock on account of its hardiness and relatively good size. The first sheep introduced into the Department included two ewes and one ram which arrived here on July 8, 1922. The ram was a pure-bred Indian while the ewes had infusion of Merino blood on Indian stock. The present size of the College flock is 20 head.

It is the aim in the goat project to produce a type of animal which will give a reasonable amount of milk, enabling the small farmers to own a few does for their milk supply. Again, the Indian breed of goats is found to give an appreciable quantity of milk for a relatively long period of milking. When bred to an established dairy breed, like the Nubian, the resulting, grades are expected to produce a high milk yielding goat of sufficient hardiness to withstand tropical conditions.

The first herd of goats was acquired by the Department in 1913. The animals did not thrive well because they were left in the pasture by themselves and almost all of the original stock perished from various causes. On July 8, 1922, one Indian buck and one Indian-Spanish doe arrived from Alabang Stock Farm. With the use of the buck on the native does, Indian grades were produced. Four grade Indian does were purchased from the Calamba Sugar Estate, Laguna, on November 2, 1925, together with a registered Nubian buck imported from California The Nubian buck was then allowed to breed all the Indian grade does from the time of arrival until a few months before his death on January 22, 1929, so that his breeding period was about three years. The present stock of the Department, therefore, consists mainly of Nubian grades.

The small goat dairy, including the sale of chevrons from wether goats and a few breeding animals, gave an average yearly income of ₱278 during the last five years. At present the Department has 49 head.

The Animal Husbandry Plant

Swine

In 1910, the first swine stock was acquired for instructional purposes. In 1913, the Berkshire and Yorkshire breeds were introduced to improve the native pigs of the College herd. The other breeds which have found place in swine breeding operations were the Duroc Jersey and the Poland China.

The introduction of foreign breeds of swine necessitated repeated replacements due to deaths resulting generally from kidney worm infestation. Even the immediate progeny of pure-bred boars of foreign breeds on native animals could not endure the effects of parasitism. So upon the Jalajala pigs, belonging to a large strain of native swine, the initial work on the formation of the Berk-jala swine was started by using the Berkshire. The object in using the native blood was to impart resistance to diseases, particularly with reference to parasites, while the Berkshire blood was intended to improve the conformation and ability to make economic gains. Besides size, conformation and resistance to diseases, other specific points aimed at in the establishment of the breed are (1) the ability of the sows to produce two litters yearly, (2) the production of eight pigs to the litter and the successful rearing of 80 per cent of them and (3) the attainment of 100 kilograms live weight at the age of one year. Early maturity was also a point considered in the process of selection, in as much as the native pigs are late maturing animals.

The original sows from which the present Berk-jala stock came were purchased on November 29, 1915. It will be some time before definite characteristics of the new breed can be fixed, but already much progress has been accomplished. This is possible because of the rigid care exercised in selecting individuals that are to be mated together.

Besides the work on the Berk-jala, a great deal of attention is paid to determining the efficiency of different rations for the production of pork, and their cost. Other investigations of varied nature are carried out.

In the process of selection necessary for the mating of only choice animals in the formation of the Berk-jala breed and from other experiments carried out in this project, a number of animals are continually made available for slaughter. The pork produced affords material for the study of meat preservation and maintains a trade for the Revolving Fund. The magnitude of the business in swine may be seen in the returns for 1928, when the highest point was reached, amounting to ₱2,801.

The number of hogs the Department has is 203.

Poultry

After experiencing numerous set-backs in the handling of poultry breeds from the temperate regions, the raising of the Cantonese chicken was tried. Coming from an Oriental neighbor, the Cantonese fowls responded favorably and through selection for type, color, and egg production, the two dozen eggs gotten from the Alabang Stock Farm on June 21, 1916, led to what is now known as the "Los Baños Improved Cantonese" chickens. The ideal sought for in the Cantonese chickens is a fowl of buff color, possessing the hardiness of the native, yet one which responds well to confinement, is of medium size, with yellow skin and shank, the eggs large and light in color, and with an average yearly flock egg production of 135 eggs for each hen.

Since the beginning of this work no outside blood has been introduced. Intensive inbreeding, therefore, took place among the fowls. Strict selection for good points, including vigor, prevented the production of weak or otherwise poor stock. The improvement in egg production may be judged from the record of pullets in 1917—1918 amounting to an average of only 29.8 eggs, while in 1923—1924 the average was 109.7 eggs. At present the highest egg production record at the Department is held by a Cantonese pullet which has laid to date (July 31, 1929) 204 eggs with one more month to go.

The total number of Cantonese chickens at the Department is 438, or more than half of all poultry.

Besides the work on the Cantonese, the Department is concentrating its efforts on the improvement of the Nagoya and Native chickens.

The Nagoya is a dual-purpose fowl which is the prevailing breed of chicken in Japan. Its merits lie principally in its vigor, hardiness and relative adaptability to Philippine conditions, in the uniformity of type and color, in the large size of body and reasonable production of large eggs of brown color. The first thirty eggs of this breed were brought over by Doctor Gonzalez from Japan, from which fourteen were hatched and eight chicks grew to maturity. To-day there is a total number of sixty Nagoyas at the Department.

In 1922, initial work was started in establishing the characteristics of the Native poultry as a breed. Brown was selected as the standard color. Black shank and white skin are the other points for which this fowl is being bred. Besides establishing the type, the birds are being improved in egg production, size of body and responsiveness to close confinement. At present the Native chickens reproduce themselves uniformly. In 1926-27 one pullet gave a total production of 197 eggs.

The other poultry owned by the Department are kept for instructional and experimental purposes.

The first introduction of standard breeds of poultry into the Department was in 1913. Black Orpington was one of the breeds kept before. The other breeds which have been kept in the Department for a long time without the introduction of new stock from outside are the Rhode Island Red, Barred Plymouth Rock, and Single Comb White Leghorn.

The other breeds of chickens raised at the Poultry Division mainly for instructional purposes, include the Black Minorca, Silkies, Frizzles, and

Japanese Bantam. Of the other kinds of poultry, there are turkeys, Chinese geese, White Chinese and Native ducks, Native pigeons and Pearl Guineas.

The total number of poultry at the Department amounts to 806 birds. In financial returns, the yearly income rose from ₱864 in 1924 to ₱1,690 in 1928.

Buildings and Other Permanent Structures

The first building constructed for the Department was a combined stable and bodega which was completed in January, 1911. This building now houses the College armory.

The first two-story animal husbandry building to house the offices and classroom was built in 1913. This is now known as the Poultry Building.

The present Animal Husbandry Building housing the offices, lecture rooms, library and stock pavillion was built in 1921. To complete the building, the portico and the south wing were added in 1929.

The weighing scale was installed in 1923, on each side of which two corrals were provided.

Soon after the burning of the old hog house a new structure was built on July 23, 1924.

The main gate leading to the animal husbandry ground was erected in 1924, and following this, in 1925, the three units of shed forming a quadrangle with the animal husbandry building were constructed. These sheds accomodate the horses, dairy animals, milk room and store rooms. The concrete bridge crossing the Bo-ot Creek was built in 1927. The following year the silo, south of the dairy barn, and a hospital shed were put up. The hog judging barn, the concrete alley connecting this with the hog house, and the goat and sheep barn were all completed in 1929.

The seven laying houses and adjoining pens were built in 1920. The long laying house along the poultry road was built in 1927.

In 1924 the Poultry Laboratory Building was constructed. It is a two-story building with an incubator cellar, feed bodega, a dormitory for the guard, a pigeon loft and several compartments for natural brooding.

Besides the above constructions, the Department engages a fencing force which is continually busy repairing broken fences or putting up new ones. Concrete posts are being made for permanent fences.

Pastures

In 1911, ten hectares of land were set aside for pasture and the growing of forage. The "Pagitan" pasture located between the Pili and Molawin Creeks was also given to the Department for cattle and water buffaloes. Recently, however, this area was transferred to the Department of Agricultural Education.

Since 1917 the Department has been using the "Tanza" pasture belonging to the School of Forestry. This has an area of about 21 hectares.

In the establishment of the experiment station at this College, the Department received its share consisting of 120 hectares, which has been subdivided into smaller units for pasturing various classes of the large animals of the Department.

A portion of the land of the Department is devoted to the production of forage and grain for live stock. Since 1924, 43,538 kilograms of shelled corn and 15,685 kilograms of palay have been harvested, while during the last four years 4,161 kilograms of root crops have been produced. For the production of these crops about seventeen hectares of land are now used.

RESEARCH

To date the Department has 118 published papers to its credit, of which 41 are on poultry, 20 on swine, 11 on cattle, 9 on horses, 4 on carabaos, 3 on dairying, and 30 on miscellaneous topics.

Of the accomplishments along experimental lines, the creation and establishment of the Berk-jala, the improvement of the Cantonese to produce the "Los Baños Improved Cantonese" chicken, and the findings on the hereditary nature of osteoporosis deserve special mention.

ANIMAL HUSBANDRY REVOLVING FUND

The A. H. Revolving Fund was approved by the Board of Regents on March 26, 1923. Its creation provided for the disbursement of funds collected from the different activities of the Department for the purchase of animals, feed, equipment, construction material, and for labor.

During five years of its operation the gross returns total ₱51,003, the range of yearly income being from ₱7,661 in 1925 to ₱15,680 in 1928. This income was derived from projects on horses, cattle, water buffaloes, swine, poultry, goats, sheep and dairy; the sale of firewood and charcoal, ice and crops; charges on animal labor and technical service; and income from miscellaneous matter.

The Revolving Fund has enabled the Department to raise its standard of instruction and research by providing for the necessary equipment, buildings, feed, and labor to carry on experimental work.

SERVICE

The community of the associated Colleges at Los Baños is beneficiary of the services extended by the Department principally through the operation of the A. H. Revolving Fund. Wholesome and sanitary food products of wide variety, and other household necessities are made avilable at reasonable prices.

Those in charge of the different projects and services of the Department answer inquiries and conduct consultations on matters related to their respective lines. Six of the circulars prepared by this office are intended to help the farmers in their animal husbandry work.

From time to time men of this Department have been sent out to answer calls for the planning of poultry farms or to extend technical service on private ranches. Several members of the staff have also performed caponizing, castration, and spaying operations on animals belonging to private owners.

The Department has selected males of all classes of farm animals that are kept for the breeding of outside animals. In a similar manner, the influence of good breeding is extended to outside stock through the sale of breeding animals.

In accordance with Act 2850, the Laguna Poultry-Swine Station was established at the College in 1919 under the direct supervision of the Department. In as much as the public did not fully avail itself of the privileges of the Station, its closing was recommended and approved on December 31, 1924.

RANCHERS' CLUB

The Ranchers' Club is a student organization of which students majoring in animal husbandry are members. Other students are admitted into the organization upon unanimous consent of the members. Members of the faculty of the Department are honorary members of the Club.

The Club was founded on August 22, 1922, by Doctor Fronda who has since then acted as its adviser. The main object of the Club is to aid in promoting interest in live stock in the Philippines. Once each year the Club celebrates its day with a program, live stock parade or show, and the traditional ball.

DEPARTMENT OF ENGLISH

EMMA S. YULE

Professor of English and Head of the Department

No edict, no decree, no resolution, not even a faculty or Board of Regents motion brought the Department of English into being. It was never established. No record heralds the first day of its existence. It seems to have gradually taken form out of nothing. Cosmos out of Chaos? Impossible. No such condition as *chaos* was ever existent on this campus. Apparently, when the English work in the class room and out had made itself felt as an entity and not a fraction, the title "Department" was given it in the catalogue. It may be said as a cushion to soften the blow on pride that the word "department" carried little weight in the early days of the College. Indeed, it probably was not in the "daily dozen" of organization words. The members of the faculty each taught his special subject and "filled in" in other subjects when needed.

The important fact to record is that English was taught in the opening year of the College. English 1 and 2, both preparatory courses, were offered. Mrs. Carrie Stein Ledyard was the sole instructor. In 1911—12, during Mrs. Ledyard's absence on leave, Artemas Day, a biologist, occupied the "chair."

Kenneth Whitney Duncan and Austin Craig opened up the year 1912—13, but Mr. Craig held the fort only a short time.

From 1913—1915, Mrs. Dorothy Rundles was in charge. In this period English 3 as an elective, a college course, was added to the work. This English 3 seems to have been a sort of "Botany Bay" to which the dean could sentence students whom he considered "defective in English." This course was related to agriculture, particularly through use of the United States Department of Agriculture yearbooks.

In the succeeding years up to the present, among names on the roster of the Department are: Mrs. Charlotte R. Gillis, Emma S. Yule, Jacob Wodrazka, Ruth Taylor, Thaddeus Brenton, E. Gertrude Madison, Dorothy Hall, Mrs. Alma Burton, Thomas O'Leary, Marcia Whipple, Margaret Wilson, and the present staff, Esther Anderson, Caroline V. Lee, Anne F. Cole, Sue Denny, and Emma S. Yule (on leave). There are others whose sojourn for various reasons was too brief to warrant placing their names on the list.

In the early days, especially from 1912—1915 when the staff consisted of one member, other members of faculty and graduate and student assistants were drafted in to "help out" in teaching English.

In 1916, Emma S. Yule and Mrs. Charlotte R. Gillis were appointed as instructors in English. Miss Yule reported on opening day after Christmas holidays. In the proceding months, Mr. José Dacanay, who was graduate assistant in German, taught two English classes. In making marks on the wall to show the periodic growth of the English work in the College the "Moving Finger", or time marker, if we must be prosy, should reach a bit high in 1916. Red ink might even be used. For in this year *two* English instructors were appointed. And the "reading of graduate theses for English" became part of the English work. "See that the theses are put into understandable English" was the terse direction of Dean Copeland to Miss Yule, who was a sort of non-titular head of the Department. This "reading for English" of the theses in the English Department has continued to the present day. Also the reading of copy and reading of proof for *The Philippine Agriculturist* under direction of Dean Copeland began this year and has continued to the present day. Since 1919 a member of the staff has been on the editorial staff as assistant editor—except from 1925–29, when the head of Department carried all the editorial work.

It was in the year 1916 that experimental feelers were sent out to find what was most necessary and what was practicable in English for the students in this College, where only two years of preparatory English were required and only one College course was offered and this an elective.

On the fifth day of Miss Yule's work, she sought an interview with Dean Copeland. The interview went something like this: Miss Y.: "Your hope for your students, Dean Copeland, is that they will be connected with agriculture, is it not?" Dean: "Well, something of that kind." Miss Y.: "As English is not quite the students' mother tongue as yet, what is your opinion of keeping the English work in the College fairly closely allied to farming in the Philippines? In other words, emphasize one vocabulary and form of expression?" Dean: "If I get you, and I think I do, my opinion is the same as yours. Heard a student the other day trying to explain 'The Squirrel and the Mountain.'" I thought then, 'What bosh, the boy never saw a squirrel cracking a nut, and anyway Emerson's idea is as far away from him as Mars.'" Miss Y.: "Then I assume you have no objection to my working out courses which seem practical for this College." Dean: "Not a bit. Dig right in."

With this coöperation, Miss Yule, beginning with English 1, gradually evolved courses English 1 and 2 preparatory into courses in which the main part of the theme work was on subjects allied to agriculture. The oral work was largely given to explanations and descriptions of things connected with the farm. This has continued to be the central idea of the English work—definite training for the work of the students in life.

Another feeler sent out this year was conducting, at the suggestion of the dean, a class for graduate assistants. The work, really an experimental survey or test, was not rich in results for the class, but yielded much that was of practical value to Miss Yule, the instructor. And incidentally it aroused in her an interest in the possibilities for English work in the College, which has grown as the years have rushed by.

In recalling the days of evolution of the courses, the library of that period is limned clearly. It was geographically where it is today, but the territorial expansion has been imperialistic. In "those days" there was one table in the reading room. It measured about two meters in length and one in width. It so completely filled the room that should six or eight students be in it at same time they could move only crab-wise. The book stacks, plain shelves, were in proportion to the room. Surprisingly well-filled they were with books and pamphlets on *agriculture*, but not *one* volume of literature or history or such non-scientific stuff. And as for current magazines and daily newspapers, the space was a replica of Mother Hubbard's cupboard. This unplethoric condition reenforced, if it needed it, the practicability of keeping to agriculture in courses in English. It took two years to get an unabridged dictionary for the Department. And it took longer and much expenditure of time, paper, and logic before the Manila "All Highest" would approve the buying of a few maps. "A College of Agriculture does not need maps," was the indorsement on first request. The time, paper, and logic were used to contravene this dictum or doctrine. After about three years' persistent pounding, maps of the continents were secured.

This is a fitting place to record that the first books of a literary nature to be placed in the library were bought with the proceeds of "The Court Scene from Merchant of Venice" which was given under the direction of Mrs. Gillis in the first semester of 1915—16. This was also the first dramatic performance on the campus.

After some years of restrained struggle on the part of the head of the Department, English was made a required subject in the College curriculum in the six-year course, later in the four-year course. Today, four College courses are given.

The dual job of reading theses "for English," and copy and proof reading on *The Philippine Agriculturist* in the English Department led to some changes of value. Dr. Sam Trelease, a plant physiologist in the College, was appointed about 1919 by Dean Baker as editor of *The Philippine Agriculturist*, with Miss Yule as assistant editor. This marks the first appearance of "English Department" on the mast head of this journal. Doctor Trelease, by nature and by lifelong training, is systematic. His knowledge naturally runs into neatly labeled compartments. Manuscripts, each prepared according to practice or training or non-training of writer; theses, the parts of which did not click into place, caused the editor to do all things that men do when rather desperately irritated. But this man is not one to grouch, but to change, improve.

So one day "Doctor Sam" sauntered into the "English office," which was a class room with one straight-backed chair and a deal table with one small drawer. Doctor Trelease: "I'm wasting my time rearranging every one of these papers. Can't we draw up some regulations and insist that papers be prepared according to them?" Miss Yule: "Fine idea! Why not go further and draw up the same rules in such a form that they can be taught in all classes. That is, require all theme work to follow them." Nature made no outward manifestations in recognition of the event, but in that brief space of time in that "office" in the southwest corner of the Administration Building the idea of the "Preparation of Scientific and Technical Papers" first squirmed into the light.

If any one questions the practical value of this little book on this Campus, let him find, if he can, a copy of theses as submitted before it came into use and the ones now submitted. One individual's memory will always hold one thesis manuscript written in longhand, of 120 pages on a vegetable, the results of over a year's work in experiment. The writer, the "English reader" found, knew a vast deal about that vegetable and what he had been doing with it, but his paper was "confusion worse confounded." O, the weary, weary time consumed in getting that vegetable into anything resembling form! Today, the "English reader" would say, "See the manual on such and such a page." Surely "Doctor Sam" acquired merit by that work far beyond that for what be did on "salt nutrition experiments."

The English Department has always taken the stand that teaching English in the class room is only part of its work in instructing. It is its policy to stand ready at all times to give help to anyone who asks in revision of letters, manuscripts, etc. Some hundreds of pages are submitted each year. This aid, it is believed, is of much benefit in improving the English written in the College.

The stand taken that the required fundamental courses should be intimately connected with farming rather than with the literary phase has not meant that the Department has not worked to give glimpses, at least, of some things that are not allied to making the proverbial two blades grow where only one had held the ground. The Department early realized that it was its part to do what it could for the cultural side of the student's life. To this end, appreciating the Filipino's liking for the dramatic, effort was made to do something for the students in this line. No courses could be given. There was no stage on the Campus. Each member of staff always carried fairly heavy work. But we have come a good ways since Miss Madison "presented," in 1923, "Exchange" on a few rough boards for a stage. The members of the staff whose names will always be writ large in this work are: E. Gertrude Madison, Margaret C. Wilson, and the present director of Mimics, Anne F. Cole. Each took up the work where her predecessor stopped on returning to the homeland. And for the past two years an incalculable debt of gratitude is due Rev. and Mrs. Hugh Bousman, of the Student Church, for their competent help. Since 1923 several plays, both foreign and Filipino, have been presented. Two original productions, one, "Doctor Research to the Rescue", later issued by the Department as Circular No. 13, and "The Cadets' Sweethearts," a musical play by Miss Cole, have been presented. And to this list the pageant portraying the history of the College, to be given October 10, 1929, can be added. The stage, the curtain and the little in the way of properties are material evidence of the dramatic "urge" in this Department. The Mimics is now a "going concern" giving one hour a week to study of things pertaining to drama, all under as close supervision by the Department as the class work. The letters that have come from the provinces tell of results in the aim of the Department to give training that will help students to do something of a like kind wherever they may live.

The weekly "College Sing" also was started under Miss Madison. While still rather nebulous it has done something to stimulate group singing on the Campus. It is ready, under the right leader, to take form. Even without form it has led to the writing of some local College songs.

With all due modesty the small department housed in the upper story of the Old College Building can say, "We also have served."

DEPARTMENT OF ENTOMOLOGY

LEOPOLDO B. UICHANCO

Professor of Entomology and Head of the Department

Entomology was one of the first eight departments to be organized at the College of Agriculture. For over five years, however, from 1909 to 1914, it remained as a "purely teaching department" with "a considerable part of the time of the one teacher, Mr. Ledyard,...required for assistance in the administration of the College."[1] Two one-year subjects, of ten credit units each, were given—one in introductory zoology and another in economic entomology. Both were required courses. A collection of insects and some specimens of other animals were accumulated during that period; but these consisted largely of undetermined material and were almost valueless for general reference work. A small culture of mulberry silkworms, from strains which had been developed in the Bureau of Science, was maintained in an especially constructed silk house, located on the eastern third of the concrete ground floor of what is now the Soils Building. There was, moreover, a small concrete insectary, which still exists on its original site to the south of the Old College Building. During that period, however, the insectary was very seldom used. Indeed, it remained during all those years as a mute symbol of the beginning of entomological work in the tropics, where there is so much to do that frequently the new worker gets lost at first in the multiplicity of problems confronting him and finds difficulty in making a start.

Fresh hopes were held for the Department when the section of entomology was abolished in the Bureau of Science, and its entomologist, Mr. Charles S. Banks, who had been engaged in that work in Manila for about twelve years, was transferred to the College of Agriculture as assistant professor of entomology. He entered on his new duties on August 1, 1914, the same date that Mr. Ledyard resigned. The following year, the Bureau of Science entomological collection, which was then reputed as unsurpassed in the Orient, and also the Bureau's entomological library were deposited in the College. An innovation made in the course in entomology was that breeding of pests in the insectary was emphasized, and no students could pass the subject without carrying through to completion the life histories of two or more insect species. Insect anatomy, general insect collection, and taxonomic work were, likewise, given close attention. Zoology remained as a sideline to entomological instruction, although distinct improve-

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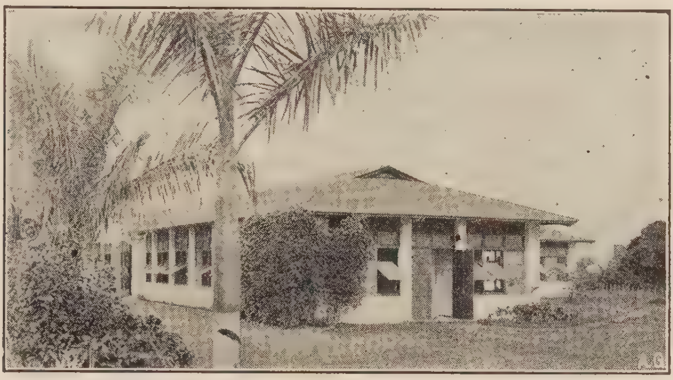
[1] Copeland, E. B. 1917. The work of the College of Agriculture. The Philippine Agriculturist and Forester 5: 1-36.

Professor Edgar Madison Ledyard

ments in laboratory work were introduced, especially in that each student was required to conduct individual dissection work and collect and classify a set number of zoological specimens. He was also made to prepare skeletons of vertebrates for study.

It was the Department's good fortune that during those formative years the late Dean C. F. Baker was already connected with the College of Agriculture in his capacity as professor of agronomy and head of the Department of Agronomy. He arrived at Los Baños in August, 1912, after more than a decade of scientific experience in various countries of the world, in part in the western tropics. He had already an established reputation as an entomologist before he turned his attention to agronomy. His entomological labors at Los Baños, carried on entirely as a private enterprise and outside his official duties at the College of Agriculture, which made the insect fauna of the Philippines, and especially that of the Maquiling region, one of the best known in the tropics, are already too well-known to need repetition here. While it is a matter of record that he was connected with the Department of Entomology as acting head for at least one year, in 1916, he did not relinquish his position in the Department of Agronomy at the time and he never taught a course in either entomology or zoology. His relation with us was purely advisory during that one year, when Professor Banks was on leave of absence. Zoological instruction was then temporarily suspended due to lack of personnel.

At all times Professor Baker was generous in his response when approached for help in entomological and zoological matters; and he even gave freely of his private collection to supplement our Department material. His zeal and energy were contagious and it was an inspiration, at least to us younger men, to fall under his influence. Before his death, his insect collection had become increasingly valuable through the large mass of specimens, many of them cotypes determined by numerous specialists in different parts of the world, and his opinion on puzzling questions in entomology was frequently sought by his coworkers. When Dean Baker died in July, 1927, not only was his advice no longer ours, but even his priceless collection, which had proved so indispensable to us, was soon to leave Los Baños for the U. S. National Museum in Washington. In the Department of Entomology we bore the loss with the poignant self-pity of a disinherited orphan, vainly trying to find solace in the following counsel from Dr. L. O. Howard:


Entomology-Plant Pathology Laboratory

> "It may be a source of regret to people in the Philippines that this wonderful collection is going to a distant point, but even from their point of view this is best. At present the existence of the collection is in danger from pests or from fire. Here [in Washington] it will be housed in a large fireproof building, will be cared for by trained and loving hands; and when in the Philippines (I hope in the near future) safe museum facilities are provided, a new collection can be built up, and the proper names can be gained from comparison with the identified Baker material."[2]

Significant also during that period of transition of the Department of Entomology was the first coming to the College of visiting foreign entomologists; in 1915, Professor Lawrence Bruner, of Nebraska, spent a few months working on Philippine Orthoptera; and during the years 1915 and 1916, Dr. Frederick Muir and his two assistants, Dr. Francis X. Williams and Mr. H. T. Osborn, came to secure parasites for sugar-cane insects in Hawaii. To the students especially, but even to the members of the faculty, the effect of being brought into intimate contact with contemporary workers from other parts of the world was far-reaching. The writer, then a young assistant, still derives a great deal of personal satisfaction from looking back to the work of those entomologists and recalling that he was an eyewitness to one of the most dramatic episodes in the history of biological control of insects—the finding at Los Baños of a Philippine parasitic wasp, *Scolia manilae* Ashmead, which, when introduced into Hawaii, within a comparatively short time controlled the white grubs, *Anomala orientalis* Waterh., that had seriously threatened the ruin of the Hawaiian sugar-cane industry.

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[2] Howard, L. O. 1928. Charles Fuller Baker: A Man of Achievement. The Philippine Agriculturist **16**; Special Number: 43.

The first advanced course in entomology was given in 1915, to one student. The elementary courses in zoology and economic entomology continued to be required as one-year, ten-unit courses, until 1917, when the latter was made optional with the then newly introduced subject of plant pathology, under Professor Reinking. The results were rather disastrous for entomology, for most of the students elected plant pathology. The following year, both economic entomology and plant pathology were shortened into one semester courses and required of all students. That arrangement still holds at present.

A master's degree was first granted in 1918 to one student who majored in entomology; but up to that time no undergraduate had taken any thesis work in this Department. Leon B. Edrozo, B. Agr., 1917, worked on tobacco leaf worms and F. Q. Otanes, B. Agr., 1918, on the bean fly, but both of them were registered as thesis students in agronomy, with Professor Baker as adviser.

Professor Banks resigned from the College of Agriculture in April, 1919, in order to reestablish entomological work in the Bureau of Science. Consequently the Bureau of Science entomological library and insect collection were then returned to Manila. The period from 1919 to 1920 was an interregnum, with only young assistants directing the affairs of the Department. Professor Baker was then dean of the College and had much less time than in 1916 to devote to the Department of Entomology; but he managed nevertheless to give instruction in advanced entomology and in special problems. One of the direct results of the lack of personnel was the abandonment of the work in sericiculture.

"After going over the United States with a fine-toothed comb to find some one who would come," as Dean Baker expressed it in a letter, the University finally succeeded in securing the services of Mr. H. E. Woodworth, who entered on his new duties as professor of entomology and head of the Department on September 15, 1920. He had had good basic training in entomology in the University of California, which, coupled with his fresh enthusiasm and energy, made him a very valuable asset at a time when this Department was sorely in need of some one to set it again on its feet. A three-unit course in veterinary entomology and another in forest entomology were added to the list of courses; and by a co-operative arrangement with the College of Veterinary Science, a member of the faculty of that College was detailed to teach agricultural zoology.

Entomology students observing insects at work

On April 19, 1921, a substantial sum of money, ₱4,000, was donated to the University by the Hawaiian Sugar Planters' Association "to be utilized in the erection of an insectary in Los Baños for the purpose of furthering entomological work in the Philippines and in appreciation of the courtesies and co-operation extended." Work on the construction of a modern, ant-proof insectary was immediately begun, and the building was ready for use the following October. This generous gift was especially noteworthy in that, quite aside from its significance as a tangible expression of good will from such an important scientific entity, this was the first donation to the University from private sources.

With the return of the writer in May, 1922, from a three-years' absence to pursue graduate work in entomology at Harvard, he resumed his duties in the Department of Entomology, ultimately succeeding to its headship after the resignation of Professor Woodworth in January, 1923. Dr. D. V. Villadolid, the next ranking member of the staff, returned in June, 1927, after three years' graduate work in vertebrate zoology at Stanford. He has since been in charge of the work in agricultural zoology. With an especially trained man thus assigned to this phase of the Department's activity, our zoology has finally ceased to be a mere teaching subject and "back trailer" of entomology. The present staff is composed of seven members, five of them having long and continuous service in the Department, the period of their connection ranging from six to seventeen years. All of them are graduates of this College, who have literally grown up with the Department and have worked their way from the bottom.

The present courses are offered in the Department of Entomology:

Zoology 1. Introductory Economic Zoology. First semester. Credit 5 units.
Zoology 2. Vertebrate Zoology. Second semester. Credit 5 units.
Zoology 3. Introductory Economic Ichthyology. Summer. Credit 5 units.
Entomology 1. Economic Entomology. First or second semester. Credit 5 units.
Entomology 5. Insect Collection and Elementary Entomotaxy. Summer. Credit 3 units.
Entomology 103. Insects Affecting Field Crops. First semester. Credit 5 units.
Entomology 104. Insects Affecting Sugar Cane. Second semester. Credit 5 units.
Entomology (or Zoology) 99. Special problems in economic entomology or agricultural zoology.
Entomology 199. Seminar.
Entomology (or Zoology) 100. Undergraduate thesis.
Entomology (or Zoology) 300. Master's thesis.

To date there have been fifteen students who have been graduated from the College with bachelor's degrees and two with master's whose major work was conducted in this Department.

Along research lines, the more salient entomological contributions have been on the biology and control of insects affecting agricultural crops and domestic animals. Rather extensive reports have now been published on the rice bug, corn borer, banana weevil, sweet potato weevil, rice root louse, Philippine plant galls, mound-building termites, flea beetles, *Prays citri*, Philippine cotton boll weevil, and carabao foot maggot. Preliminary host indices of Philippine insect pests, a summary of insects affecting sugar cane and a similar one on rice have also been contributed from the Department. During recent years, some work has likewise been done on biological control of insects, including exchange of beneficial forms with foreign countries.

Since the return of Doctor Villadolid, he and his students have been engaged principally in the investigation of fresh water fisheries of Laguna de Bay. A paper covering the results of the work on the life history of kanduli (*Arius* spp.) has just been released and a series of studies have been undertaken on the dalag (*Ophicephalus striatus* Bloch) and other important food fishes, for the purpose of determining feasible means for their conservation and protection. In order that more adequate observations may be made of the rich and varied biota of the lake, the Los Baños Limnological Station has been established, at the instance of Dean Gonzalez. This station consists of a tract of 1.4371 hectares of land along the foreshore of Laguna de Bay in the barrio of Mayondon, Los Baños, which has been declared an insular reserve by executive proclamation of the Governor General No. 176, on August 17, 1928. A building of mixed material to serve as laboratory and store room is being constructed on the ground and is now almost ready for occupancy. The station is within easy reach of the College campus.

The present sketch will not be complete unless further remarks are made about the foreign entomologists who have made the College their headquarters while working in the Philippines. With facilities for foreign travel not always readily accessible to members of our staff, the menace of stagnation through protracted isolation from fellow workers in other parts of the world constantly hovers over us. The transfusion of new ideas brought in periodically by these visitors from other lands and the fresh stimuli from contact with them have compensated for this lack of travel. In addition to Professor Bruner, Doctors Muir and Williams, and Mr. Osborn, we have had the privilege of having in our laboratory the Hon. Nicolas Ikonnikov, of the Academy of Science, Moscow, Russia; Mr. C. E. Pemberton, Mr. R. H. Zwaluwenburg, and Mr. E. M. Ehrhorn, of Hawaii; Dr. Filippo Silvestri, of Italy; Dr. E. Mjöberg, of Sweden; Dr. Inokichi Kuwana, Dr. S. Kinoshita, and Mr. Tei Ishii, of Japan; Mr. Shuzo Takano, of Formosa; Dr. K. W. Dammerman, of Buitenzorg, Java; Mr. R. A. Cushman, of the U. S. National Museum; Prof. W. E. Hoffman, of Canton Christian College, China; and Mr. C. P. Clausen, of the U. S. Bureau of Entomology.

Los Baños Limnological Station at Mayondon, on the shore of Laguna de Bay
Mt. Maquiling and village of Los Baños in background

DEPARTMENT OF MILITARY SCIENCE AND TACTICS

AMADO MARTELINO
First Lieutenant, P.S., U.S.A.,
Formerly Assistant Commandant, University Corps of Cadets

Military Science in the College of Agriculture was organized in 1916. In the beginning instruction was very elementary, consisting mostly of the rudiments of close order drill. Bamboo canes were used for rifles. The following year saw an improvement in the equipment. The bamboo canes were discarded and wooden rifles were introduced. A student who had had previous training in close order drill and a few selected student assistants were in charge of instruction.

In order to give the cadets a more thorough and systematic training in military drill, special arrangements were made by the President of the University with army officials in 1918 whereby Sergeant Victoriano J. Estivañez (P.S.) and two corporals from Camp Eldridge, Laguna, took charge of the military drill in the College. For this work these three non-commissioned officers were given nominal compensation. With this change, great

Cadet Officers with their Instructors

improvements were introduced in that not only close order drill was taught but also the elements of musketry, calisthenics, and scouting and patrolling. Wooden rifles, however, remained in use.

Up to 1921 all students enrolled in the College were required to drill one hour daily. Beginning the academic year 1921-22 this ruling was changed and only the preparatory and the first and second year collegiate students were required to take military drill. This year the non-commissioned officers detailed from Camp Eldridge were withdrawn and instructions in military drill were conducted under Mr. Ponciano E. Valle, an ex-soldier who was taking a special course in the College.

The year 1922 marked a new era in the history of this Department. The Philippine Legislature, seeing the need of an elementary knowledge of military science among the Filipino youth, requested the War Department, through the late Governor General Leonard Wood, to assign regular army officers to take charge of military drill. This request was granted and a Department of Military Science and Tactics was created in the University of the Philippines. Captain Chester A. Davis, Infantry, U. S. Army, was assigned as the first Commandant of Cadets in Manila, while Second Lieutenant Pacifico C. Sevilla, now First Lieutenant 92nd Coast Artillery (P.S.), was assigned as Assistant Commandant of Cadets in Los Baños.

The War Department having authorized the issue of the necessary arms and equipment, military drill took on a new meaning for the cadets. A uniform was prescribed and the strict discipline of the army was enforced. Wooden guns were no longer used. These changes gave a great impetus to the interest in military drill. The cadets were no longer toy soldiers.

The course in military science is patterned after the R. O. T. C. infantry course of all American universities that have infantry units. It is divided into two groups: the basic, or required, course, which must be taken during the first two years of residence by all physically qualified male students; and the advanced, or optional, course, which is open to all those who have completed the basic course and which requires two additional years of study. The advanced course in American universities leads to a commission as second lieutenant of the Reserve Officers' Corps. This is not true in the University of the Philippines, however, although it is hoped that in the near future the War Department will recognize the unit of this University and a second lieutenant's commission in the Reserve Officers' Corps be given to those who have successfully completed the two courses.

Since the creation of the Department of Military Science and Tactics, there have been several Commandants of Cadets at Manila. The present incumbent is Major Robert A. Gillmore, 57th Infantry (P. S.). In Los Baños the first Assistant Commandant was succeeded by Lieutenant Nemesio Catalan, 24th Field Artillery (P.S.), who was in turn followed by Lieutenant Amado Martelino, 24th Field Artillery (P. S.). The present incumbent is Lieutenant José E. Olivares, 92nd Coast Artillery (P. S.).

DEPARTMENT OF PHYSICAL EDUCATION

RAMÓN P. TOLENTINO, JR.
Assistant Physical Director, University of the Philippines

Under the general administration office, the Department of Physical Education of the University of the Philippines was organized in June, 1921. Before that time, the post of physical director in the University had been held by Lieutenant J. W. Mayhew (1912-1913) and by Professor George M. Cassidy (1913-1920). It was, however, not until Dr. Regino R. Ylanan (1920-1926) assumed this position in July, 1920, that regular physical education classes were held in the University. The work of the first two physical directors was principally as athletic directors or coaches, although Professor Cassidy conducted informal classes in physical education, in compliance with the wishes of the Board of Athletic Control, and made physical examinations and anthropometric tests and measurements. Doctor Ylanan added physical education proper to athletics in his program of activities, which simply meant that not only a few but all students physically able were required to participate in some form of games or physical work. In the University Council, the late Dean Herman W. Reynolds of the College of Engineering sponsored the measure that made physical education compulsory for all University students. The courses in physical education were approved by the same body during the latter part of the academic year 1920-1921 and confirmed by the Board of Regents several weeks later.

When Doctor Ylanan left the University in January, 1927, to assume the duties of National Physical Director of the Philippine Islands, Mr. Candido C. Bartolomé became the acting physical director. Prof. Gerónimo T. Suva was then appointed to the same position in June, 1927, when Mr. Bartolomé was sent abroad as a University fellow to specialize in physical education. Acting Director Suva resigned in July, 1929, and Mr. Bartolomé, who has recently returned, resumed his former post.

The courses in physical education were made a requirement in the Los Baños Colleges during the second semester of the academic year, 1923-1924, with Messrs. Gonzalo H. Salazar (B. S. A. '25) and Dionisio Calvo (B. S. A. '26) acting as student assistants in charge. Their offices were in Dormitory C-14. Mr. Simón P. Santos was appointed instructor in physical education and stationed at the College in June, 1924. Mr. Ramón P. Tolentino, Jr., (B. S. A. '24), the present assistant physical director, succeeded Mr. Santos upon the transfer of the latter to the Manila office in June, 1926. The Department of Physical Education office in the Los Baños Colleges is at present located in Cottage No. 9, where it will continue to be until the completion of the much needed gymnasium.

The Department of Physical Education requires physical examination of all new students and medical examination of all students, both men and women, prior to registration in the University. In the Los Baños Colleges, the latter work is done by the college physician, Dr. Sixto A. Francisco. Doctor Francisco is also in charge of Physical Education 1 (Hygiene), a course given to all freshmen during the first semester of each year.

With its limited equipment and facilities and lack of personnel, the Department is trying its best to perform the task assigned to it, namely, the supervision of and instruction in physical education, including athletics. Professor Cassidy's statement in the 1916 *Philippinensian* about the Manila Colleges, which are now fairly well equipped for purposes of physical education, may well be repeated here to apply to the Los Baños Colleges at the present time:

> "The work in group games or group athletics has gone along smoothly and with better results than ever before, but this work will never reach the fullness that it should until we are equipped with a gymnasium and a swimming pool where regular classes can be held and where more time will be available for the work."

We agree with Williams when he says,

> "Physical education should aim to provide an opportunity for the individual to act in situations that are physically wholesome, mentally stimulating and satisfying, and socially sound."

TWENTY YEARS OF ATHLETICS IN THE COLLEGE OF AGRICULTURE, 1909—1929

ALEXANDER GORDON[1]
Assistant Professor of Agricultural Engineering

THE MENTORS

Unlike other colleges, where paid mentors are available to shape and guide their teams, we have had to content ourselves with local voluntary coaching from the teaching staff. Former Dean Copeland, one time miler of note, personally helped in the training of many a trackman. Dr. F. W. Foxworthy, and later Prof. J. R. Gillis, deserve great credit for the teams' showing during the first ten years of the College.

M. A. Roa, J. Wodraska, H. E. Woodworth, E. H. Pañganiban, M. Montemayor, G. O. Ocfemia, A. K. Gomez, A. Gordon and P. N. Mabbun, now members of the faculty, saw to it in later years that the baseball teams of the Aggies were at par or above those of former years. Basketball was well taken care of by faculty members; O. A. Reinking, F. P. McWhorter, C. G. Welles, E. Quisumbing, C. P. Johnson, F. Soliven, and Gordon, after Professor Gillis. Under various men, including Professor Reinking, Mr. N. Catalan, Dr. M. A. Tubangui, Mr. S. P. Santos, Mr. P. A. Rodrigo and Mr. R. P. Tolentino, Jr., the track and field teams have always been formidable contenders in inter-collegiate meets.

Later, other sports were included in intercollegiate meets. The college teams in soccer football, boxing, volley ball and others were coached at one time or another by D. Calvo, Tolentino, Jr., Gordon, A. B. Catambay and others.

It is worth mentioning that of the past corps of voluntary coaches, a number have been at one time athletes of note in the ranks of the Aggies. Pañganiban was a member of the baseball and tennis teams; Gordon, baseball, basket-ball, track and field; Mabbun, baseball; Quisumbing, basketball, track and field; Soliven, basket-ball; Catalan, track and field; Rodrigo, track and field; Tolentino, Jr., tennis, track and field; Calvo, basket-ball, swimming, soccer football, boxing, track and field; Catambay, baseball.

THE TEAMS

The college teams from 1909 to 1916 were composed of athletes from the College of Agriculture only. When the Forest School was separated from the College of Agriculture, the Rangers were always thrown in with the Aggies. Thus, the Aggie teams from 1916 to 1919 were formed of Aggies and Rangers.

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[1] Representative to the Board of Athletic Control of the Athletic Association of the University of the Philippines from the Faculty of the College of Agriculture.

The College of Veterinary Science was transferred to Los Baños in 1919. The Aggies from 1919 to date were reinforced with the Veterinary athletes. Later, the Aggies were called, as they are now known, the University of the Philippines Los Baños team.

With all these rearrangements, the Aggie Spirit has permeated the atmosphere in our athletic life. The Aggies continue to contribute a formidable share to the list of notable athletes.

THE MEN

The Aggies have had, and are still having, a bevy of crack men in all branches of athletics in which they take part. N. B. Mendiola, H. Francia and a few others were well known in tennis in the early days. Later years had A. T. You, I. Sevilla, R. P. Tolentino, Jr., R. Betia, A. Hizon, J. Utzurrum and a number of others to bear the brunt of putting the Aggies in intercollegiate tennis.

Basket-ball had T. Ventura, E. Quisumbing, F. Soliven, G. Antenor-Cruz, D. Calvo, R. Betia, and a host of others. Basket-ball has always been the Aggies' sport; they have taken to it as the proverbial duck to water.

Baseball is a sport in which the Aggies have unquestionably shown their mettle. Men, like E. Tabat, M. Oro, G. Labitag, H. Silayan, A. Baltazar, A. Bucoy, and G. Salazar, have left indelible memories. The Aggies have mastered baseball so well that it was claimed they played good ball in all kinds of weather, and that they probably played better in the rain.

The Aggies are well known in track and field sports. Aggies have come and gone, but the names of Tansioko, N. Catalan, Rola, Mallonga, I. Pascual, E. Quisumbing, T. Manzano, A. Alvarez, B. Leaño, B. Viado, P. Rodrigo, R. P. Tolentino, Jr., G. Salazar, and many more, will linger long in our memories.

In many other branches of sport we have had good men: D. Calvo in swimming; D. Calvo, P. Masibay, F. Villa, and others in boxing; D. Calvo, C. Suebsaeng, J. Austria, C. Fuentes and many more in soccer football; J. Marcos, M. Angel and others in volley ball.

The Aggies have never been wanting in athletes in any branch of organized athletics. When the call for men is sounded, the Aggies may be depended upon to answer. Such is the Aggie Spirit. And with the allied men from the Forest School and the College of Veterinary Science, the U. P. Los Baños teams will always be dangerous opponents and strong contenders.

U. P. LOS BAÑOS BASKETBALL TEAM, 1927-1928, VARSITY CHAMPIONS.—*Left to right: kneeling,* Villa (g), Rodriguez, Jr. (Vet. f), Lemoncito (g), Hollero (c), Reynoso (g), Betia (c, captain), Sonza (f); *standing,* Iledan (g), Austria (f), Dr. A. Gordon (coach), Mr. R. P. Tolentino, Jr. (manager), Zabarte (g), Garganta (f).

AGGIES IN VARSITY TEAMS

The Aggies are located in a wonderful spot, but far from the center of activities of the Varsity teams. Thus located it was felt to be quite a burden to transport our men to Manila for Varsity berths. Taking this into account, the records reflect great credit on Aggie athletes.

Baseball.—In this event, the following Aggies made the Varsity team of 1913-1914: G. Labitag, H. Silayan, and J. Pascual; 1914-1915, G. Labitag, H. Silayan, J. Pascual, and A. Baltazar; 1915-1916, H. Silayan, and A. Baltazar; 1917-1918, A. Baltazar; 1919-1920, A. Bucoy; 1920-1921, P. N. Mabbun, G. Salazar, A. Gordon; 1921-1922, G. Salazar, M. Javier, G. Briones; 1922-1923, G. Salazar, M. Javier, G. Briones, G. Dimapilis; 1923-1924, G. Salazar, J. Fidel; 1924-1925, no team; 1925-1926, J. Leoncio, G. Briones; 1926-1927, J. Leoncio, C. Lemoncito; 1927-1928, J. Leoncio, S. Ardonia; 1928-1929, C. Lemoncito, A. Paner, P. Ocampo, A. Guillen.

Track and Field.—In track and field, the following Aggies landed Varsity berths in the team of 1912-1913: N. Catalan, V. Sajor, G. Labitag, B. Leaño, R. Sabado, Villamil; 1913-1914, N. Catalan, V. Sajor, G. Labitag, A. Flores, Villamil; 1914-1915, T. Manzano; 1915-1916, T. Manzano; 1916-1917, no team; 1917-1918, A. Alvarez; 1918-1919, A. Alvarez; 1920-1921, B. Viado, R. P. Tolentino, Jr.; 1921-1922, A. Viado, R. P. Tolentino, Jr., P. Canario; 1922-1923, R. P. Tolentino, Jr., P. Canario, M. Tamayo, G. Salazar, L. Limpiado, P. Rodrigo; 1923-1924, R. P. Tolentino, Jr., P. Canario, M. Tamayo, G. Salazar, C. Demeterio, D. Suerte, A. Gordon; 1924-1925,

P. Canario, M. Tamayo, G. Salazar; 1925-1926, P. Canario, L. Limpiado, F. Isaac; 1926-1927, F. Isaac, L. Banaag, P. Andres, M. Tuya, P. Oabel; 1927-1928, F. Isaac, C. Demeterio, P. Andres, J. Garrido, S. Martinez, P. Paggao, T. Pepito; 1928-1929, L. Banaag, P. Andres, C. Demeterio, S. Martinez, P. Yatar, G. Garcia, J. Zabarte, Jr., C. Magno.

Basketball. Basketball men in the Varsity squad of 1915-1916: E. Quisumbing; 1919-1920, A. Gordon; 1920-1921, G. Salazar, F. Soliven, J. Crisanto, G. Antenor-Cruz; 1921-1922, G. Salazar, F. Soliven, G. Antenor-Cruz, M. Tenebro; 1922 1923, G. Salazar, F. Soliven, G. Antenor Cruz, D. Calvo; 1923-1924, G. Salazar, F. Soliven, D. Calvo; 1924-1925, D. Calvo, G. Salazar; 1925-1926, D. Calvo, R. Betia; 1926-1927 R. Betia; 1927-1928, R. Betia, M. Hollero, C. Lemoncito, B. Reynoso; 1928-1929, M. Hollero, C. Lemoncito, B. Reynoso, J. Austria, J. Marcos.

Soccer football. This is a new sport for the Aggies, but already they are winning their honors. The following have been named on the Varsity team in 1925-1926: C. Suebsaeng, R. Purnariksha, D. Calvo; 1926-1927, R. Hofileña, C. Lemoncito; 1927-1928, R. Hofileña, C. Suebsaeng, C. Fuentes; 1928-1929, no team.

Swimming.—Although there is no swimming team in the Aggies' athletic program, yet the Varsity teams of 1922-1923 and 1923-1924 had an Aggie in the person of D. Calvo.

Boxing.—In this manly art, the Aggies have had their men. The Varsity may boast of F. Villa, D. Calvo, P. Masibay in 1923-1924; and G. Agraviador, M. Monsalud, N. Poblador in 1928-1929.

Volleyball.—1928-1929, J. Marcos.

AGGIES IN THE FAR EASTERN CHAMPIONSHIP GAMES

The crowning glory of an Aggie's achievements is to be a representative to the Far Eastern Championship Games. Not a few Aggies have had the honor to represent the Philippines in these meets.

In the first Far Eastern Championship Meet in Manila in 1913, the Aggies had C. Labitag, B. Leaño, N. Catalan, and Villamil representing the Philippines in the distance races. R. Sabado was entered in the 120-yard high hurdles.

1915 saw the Far Eastern classic at Shanghai, China. Here we had T. Manzano entered for the one-mile run.

The next time the Far Eastern Championship Games were held in Manila, 1919, an Aggie in the person of A. Alvarez was entered for the shot put and the discus throw.

Highest Point Winners of the Intramural Track and Field Meet, 1928-1929.—*Left*, Severino Martinez; *right*, Pedro Yatar. Record: 38 points. (Note: Martinez has held this record since 1927.)

At the Meet held in Osaka, Japan, D. Calvo was there with the Philippine swimming team.

Of the present crop of Aggies we have two who have been with the Philippine delegation to the Far Eastern Championship Games held in Shanghai, China, 1927. B. Reynoso was a member of the basketball team and P. Yatar of the track and field crew.

AGGIE RECORDS

The Aggies have maintained an enviable position in the realm of Philippine inter-collegiate athletics. The outstanding record of the Intramural Meet is the record of the Highest Individual Point Winner which is jointly held by S. Martinez and P. Yatar. Each man piled up a total score of 38 points in the meet of 1928-1929, Martinez having made the same mark in 1927-1928.

INTRAMURAL ATHLETICS

For a number of years, the Aggies for the College track and field teams were chosen from among the competitors in the Intramural Meet. This meet was first among classes. Later it became inter-sectional, namely, Northern, Central and Visayan. Then it was between departments, but was later changed back to inter-class.

When the Physical Education Department at Los Baños was established, mass athletics was well emphasized. Now the Intramural Meet, known as the U. P. Los Baños League, carries inter-class competition not only into track and field, but into basket-ball, volley ball, and soccer football as well.

FIELD DAYS

In the early days of this College, the students conceived the idea of setting aside a day to put their athletic fields in order. To this idea the College moguls readily agreed. Thus it became a traditional affair to have Field Day once a year—when classes were excused to do their bit in the open. No wonder then that the Aggies were keenly interested in their teams.

The practice, however, was discontinued when Mr. R. P. Tolentino, Jr., Assistant Physical Director of the University, used the Physical Education classes one day in the year to do the cleaning. Thus the traditional Field Day for the College was brought to an end in 1928-1929.

TABLE 1

All-Time Aggie Records

EVENTS	HOLDERS	HEIGHT DISTANCE TIME	YEAR	MEET	PLACE
100-yard dash	C. Demeterio	10.4 sec.	1927	Intramural	Los Baños
	P. Andrés		1928	Intramural	Los Baños
220-yard dash	P. Andrés	23.8 sec.	1928	Intramural	Los Baños
440-yard dash	P. Yatar	52.4 sec.	1928	Intramural	Los Baños
880-yard run	P. Yatar	2 min. 7.8 sec.	1928	Intramural	Los Baños
One-mile run	T. Manzano	5 min. 7.2 sec.[a]	1916	U. P.	U. P. Campus
3-mile run	P. Yatar	17 min. 13.4 sec.	1928	Intramural	Los Baños
120-yard high hurdles	S. Martinez	26.8 sec.	1928	Intramural	Los Baños
220-yard low hurdles	S. Martinez	26.8 sec.	1928	Intramural	Los Baños
100-meter dash	G. García	11.6 sec.[b]	1929	Ateneo D. M.	Wallace Field
200-meter dash	P. Andrés	24.4 sec.[b]	1929	Ateneo D. M.	Wallace Field
400-meter dash	P. Yatar	52.9 sec.	1929	U. P.	U. P. Campus
800-meter run	P. Yatar	2 min. 5.4 sec.[bcd]	1929	Ateneo D. M.	Wallace Field
1500-meter run	P. Yatar	4 min. 24 sec.[cd]	1929	P. A. A. F.	Wallace Field
110-meter h. hurdles	S. Martinez	17.6 sec.[b]	1929	Ateneo D. M.	Wallace Field
200-meter l. hurdles	S. Martinez	25.8 sec.[cef]	1929	U. P.	U. P. Campus
Running broad jump	P. Rodrigo	20 ft. 9 in.	1923	Intramural	Los Baños
Running high jump	S. Martinez	5 ft. 6 in.	1928	Intramural	Los Baños
Pole vault	F. Isaac	10 ft. 6¾ in.[a]	1927	N. C. A. A.	Wallace Field
Discus throw	A. Alvarez	109 ft. 6¾ in.[e]	1917	U. P.	U. P. Campus
12-lbs. shot put	B. Reynoso	37 ft. 7⅓ in.	1929	Ateneo D. M.	Los Baños
16-lbs. shot put	G. Salazar	33 ft. 2 in.	1921	Intramural	Los Baños
Javelin throw	P. Yatar	146 ft. 9⅓ in.[b]	1929	Ateneo D. M.	Los Baños
Hop, step and jump	S. Martinez	43 ft.[ad]	1928	N. C. A. A.	Wallace Field
880-yard relay	C. Demeterio				
	L. Banaag				
	C. Magno				
	P. Andrés	1 min. 38.4 sec.	1928	Intramural	Los Baños
One-mile relay	G. García				
	J. Utzurrum				
	N. Poblador				
	P. Yatar	3 min. 54 sec.	1928	Intramural	Los Baños
800-meter relay	P. Andrés				
	M. Hollero				
	L. Limpiado				
	C. Demeterio	1 min. 37.6 sec.[a]	1927	N. C. A. A.	Wallace Field
1600-meter relay	P. Andrés				
	C. Demeterio				
	J. Zabarte				
	P. Yatar	3 min. 36.7 sec.[ce]	1929	U. P.	U. P. Campus

[a] No record, but better than the Intramural record.

[b] U. P. Los Baños–Ateneo, Dual Meet record.

[c] Better than the N. C. A. A. record.

[d] Better than the U. P. record.

[e] University of the Philippines record.

[f] Equals the P. A. A. F. record.

TABLE 2

Aggies' stand in U. P. Inter-Collegiates

ATHLETIC EVENTS	TOTAL NUMBER CHAMPIONSHIP YEARS	TOTAL NUMBER OF PLACES WON			RATING AS MEET WINNER
		First	Second	Third	
Baseball	16	9	7	0	562
Track and field	17	4	11	2	235
Basketball	11	7	4	0	636
Boxing	4	2	2	0	500
Soccer football	4	2	2	0	500
Relays	3	2	1	0	667
Tennis	2	0	2	0	000
Volleyball	1	0	1	0	000

DEPARTMENT OF PLANT PATHOLOGY

G. O. OCFEMIA

Assistant Professor of Plant Pathology and Acting Head of the Department

HISTORY AND DEVELOPMENT

The earliest course in plant pathology in the College of Agriculture was designated as Botany 4, and a description of this course first appeared in the University Catalog for 1910—1911. Dean E. B. Copeland and Mr. Harold Cuzner taught the subject from the beginning until the summer of 1913, when it was given as a laboratory course by C. F. Baker, then professor and Head of the Department of Agronomy. However, formal organization of a plant pathology course, which soon developed into a regular College department, did not take place until June, 1916, when Mr. Otto A. Reinking was appointed assistant professor of plant pathology. He arrived from the United States on July 5, 1916, and took charge of the class.

Through the efforts of Dean Copeland and Professor Baker the Department of Plant Pathology came into being in 1917. Assistant Professor Reinking was placed at the head of the new department, and the original Botany 4 became Plant Pathology 1. In 1917—1918 an advanced course, Plant Pathology 9, was given in addition to Plant Pathology 1. This course, which was much like the present Plant Pathology 2 (Methods of Plant Pathology), dealt with the preparation of media, the technique of isolation and cultivation of fungi and bacteria, and Koch's rules of proof.

In June, 1918, the writer became assistant in plant pathology, and at the suggestion of Dean Baker he was assigned to study rice fungi with special reference to those which cause disease. After having collected and identified twenty-nine species of fungi, mostly saprophytic, from rice around Los Baños the writer narrowed his work to the study of a species of Helminthosporium which was then causing serious seedling blight at the College of Agriculture. The work on the Helminthosporium disease of rice was continued in the United States in 1920 to 1923 (1924 a and b).

During the school year 1917-1918 the students in Plant Pathology 1 assisted Professor Reinking in the preparation of camera lucida drawings of fungi on economic hosts. Those students who were taking Plant Pathology 9 rendered much assistance in inoculation experiments. In 1918 Reinking published his "Philippine economic-plant diseases." This publication may be considered as the first attempt to put together an account of the diseases of economic plants in the Philippine Islands with brief descriptions of their symptoms and causes and recommendation for their control. Reinking's paper was fully illustrated with photographs and camera lucida drawings.

From about 1918 to 1920 the Department of Plant Pathology, through Professor Reinking (1921), carried out extensive coöperative work with the Office of Crop Physiology and Breeding Investigations of the United States Bureau of Plant Industry at Washington, D. C. on their citrus-canker experiments.

In April, 1918, Doctor William H. Weston, Jr., formerly pathologist in charge of downy mildew investigations, Office of Cereal Investigations, also of the Bureau of Plant Industry, carried out an extensive work on the downy mildew of corn in the Philippines. Part of the work was done in the Department of Plant Pathology.

Besides working out the diseases of economic plants, Professor Reinking became interested in building up an herbarium of plant diseases. The collection of Professor Reinking and his students formed the foundation of what has since 1924 been called the Baker Herbarium. On account of the enormous growth of the collection Mr. Emiliano F. Roldan was appointed assistant in plant pathology on March 27, 1919. Mr. Felicisimo B. Serrano was also appointed assistant on June 30, 1919. Mr. Serrano, however, remained in the Department for a brief period only.

In 1920 Mr. Collin G. Welles was appointed associate professor of plant pathology; he arrived at the College on December 14 of that year. Early in 1921 the personnel of the Department of Plant Pathology consisted of a professor and head of the Department, an associate professor, an instructor, three graduate assistants, an herbarium assistant, and a laboratory helper.

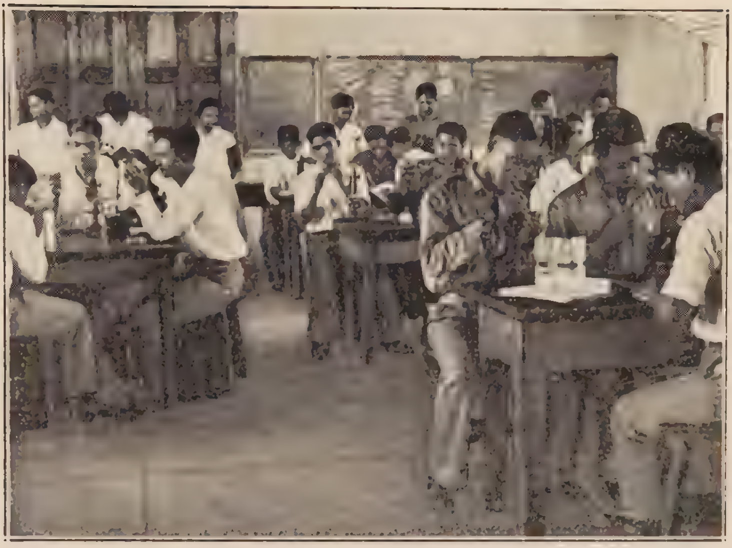
In 1921 the herbarium of the Department of Plant Pathology was enriched by Dean Baker's gift of Indo-Malayan fungi valued at ₱12,000.[1]

In April, 1921, Professor Reinking took a year's leave of absence to pursue graduate work in the United States. In the absence of Professor Reinking, Associate Professor Welles became acting head of the Department. On June 15, 1922, Associate Professor Welles resigned on account of poor health. On August 2, 1922, Mr. Frank P. McWhorter, associate professor of plant physiology, was detailed to the Department of Plant Pathology. In 1922, Professor Reinking resigned as professor of plant pathology and head of the Department and accepted a position with the United Fruit Company.

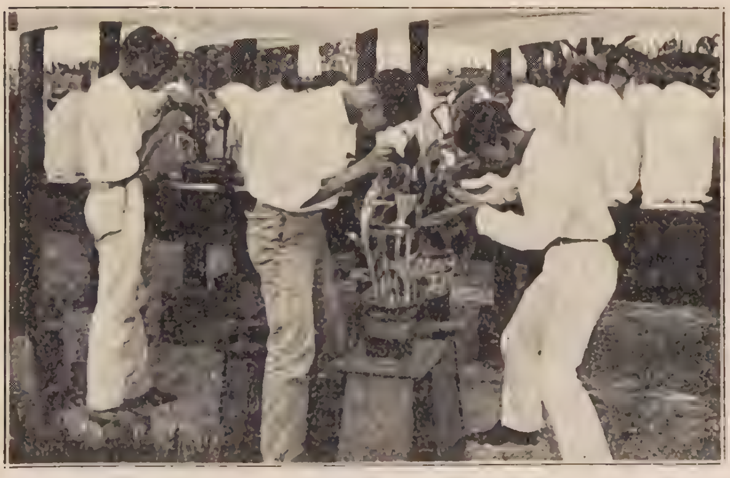
The writer returned to the Philippines on September 12, 1923, and assumed his former duties as instructor in plant pathology. Associate Professor McWhorter, who was acting head of the Department of Plant Pathology, remained at his post until his resignation on November 15, 1923.

From April, 1924, to date, no changes in the personnel of the Department of Plant Pathology have taken place above the rank of assistant and

[1] ₱1.00 (one peso, or 100 centavos) = $0.50 U. S. currency.



A class in Plant Pathology 1, Diseases of Plants; applying Koch's rules of proof to the citrus-canker organism



A type of research in plant pathology; determining the relation of sucking insects to certain plant diseases now consists of an assistant professor and acting head, an instructor, two graduate assistants, an herbarium assistant and a laboratory helper.

POLICY

Research. With the exception of minor changes that are made from time to time, the Department of Plant Pathology is following the policy laid down by Professor Reinking, namely, to study the cause and control of the important diseases of leading agricultural products in the Philippine Islands. At the same time, however, much work has been done on minor crops. Diseases of minor importance were investigated mainly for instructional purposes. The students find greater interest in their work in Plant Pathology I if the fungi of the different groups are represented by Philippine parasitic species.

Teaching. In Plant Pathology I the plan is to give the students a thorough grounding in the fundamentals of the subject. Since 1927 exercises in Koch's rules of proof for bacterial and fungous parasites have been included. With the addition of these exercises the course became much more interesting for the students and will be more useful to them when they leave the College. An outline of the general principles of plant disease control as applied to Philippine conditions has also been included.

Since 1926 a course on diseases of sugar-cane has been given every year for the students in Sugar Technology. In 1923 and again this year a course in Forest Pathology has been requested by the School of Forestry for the degree course of that school.

Beginning this year the Department offers an elective course on diseases of field crops. It is hoped that courses on diseases of vegetables and diseases of fruit may be offered in the coming years.

CONTRIBUTIONS

In addition to the phytopathological contributions made by Baker (1914, 1916), Ghofulpo (1915), Mendiola and Espino (1916), Copeland (1917) and Africa (1918), the Department of Plant Pathology worked on a large number of diseases of Philippine economic plants since its establishment in 1917.

Of the contributions of the Department that of Reinking (1919) which proved conclusively for the first time that the cause of the coconut (*Cocos nucifera* L.) bud rot in the Philippines is a fungus identical with *Phytophthora faberi* Maubl. is regarded as outstanding. Before the work of Reinking was published in 1919, it was generally believed that *Bacillus coli* Emmerich, or an organism which can hardly be distinguished from this bacterium, is the cause of this most destructive disease of the coconut. In the Philippines *Phytophthora faberi* has been found on black rot of cacao (*Theobroma cacao* L.) pods (Reinking, 1923) and blight of *Citrus* spp. (Ocfemia and Roldan, 1927). Reinking's work is regarded as of greater importance than any of the other contributions of the Department of Plant Pathology because the most practical measures are conditioned upon a thorough knowledge of the characteristics of the cause of the disease, its method of transmission, and influence of environment upon the malady, in addition to other factors.

The investigation of Doctor Weston of the United States Bureau of Plant Industry on the downy mildew of maize which was conducted at Los Baños constituted one of the most important contributions to Philippine plant pathology. Moreover, the invaluable results of Doctor Weston's work (1920, 1921, 1923) were made available without expense to the Philippine Government. Doctor Weston found that the Philippine downy mildew of maize is caused by two new species of Sclerospora which he described as *Sclerospora philippinensis* and *Scl. spontanea.*

In addition to the works of Professor Reinking on the cause of the coconut bud rot, and Doctor Weston on the downy mildew of maize, the Department of Plant Pathology in August, 1925, showed for the first time that the bunchy-top of abacá (*Musa textilis* Née) in the Philippines is due to an infective principle in the sap of diseased plants. It was further shown that this infective principle is transmitted from diseased to healthy abacá by the aphid *Pentalonia nigronervosa* Coq. (Ocfemia, 1926, 1927). Up to 1927 publications from the Philippines outside of the Department of Plant Pathology at Los Baños attributed this most serious abacá disease to *Heterodera radicicola* (Greef) and various soil conditions. Work also conducted by the Department of Plant Pathology at Los Baños showed that on abacá *Heterodera radicicola* causes root-knot, a localized affection of the roots with symptoms entirely different from those of the systemic bunchy-top (Ocfemia and Calinisan, 1928).

DEPARTMENT OF PLANT PHYSIOLOGY

RAFAEL B. ESPINO

Professor of Plant Physiology and Head of the Department

Botany was among the earliest subjects taught in the College of Agriculture, in June, 1909. In the beginning, Doctor Copeland held his botany classes in tents borrowed from the Bureau of Education. Instruction continued under such conditions until October of that year, when the construction of the first temporary building made of light materials (sawali and wood) was completed. In one of the two rooms on the ground floor of this building classes in botany were then held. Three or four other changes of quarters were made before the Department was finally housed in its present building in 1917.

From its organization to 1917, this had been called the "Department of Botany." However, owing principally to the fact that the major teaching and research work of the Department were physiological in nature, the change in name to Department of Plant Physiology was decided upon.

In establishing the Department, and in making its physiological classes the foundation of scientific agriculture, former Dean Copeland made this statement: "At the time our College of Agriculture was established in 1909, there was no college in the United States which required that plant physiology be studied by any student of agriculture." However, in the belief that plant physiology was essential in an agricultural college, Doctor Copeland included it as a required subject in the College. To quote his own words:

> —having a free hand in planning its course of study, I provided that every student not only could but must take one full-year of plant physiology, and that students taking the course regularly must have this year of physiology before being admitted to the study of agriculture itself.

This policy is still followed at the present time in this College.

FUNCTIONS OF THE DEPARTMENT

Plant Physiology is a broad subject and has certain important applications. Professor Livingston of Johns Hopkins University once truthfully stated that, as with other sciences, plant physiology, in general, has two groups of applications. One application is in the formation of what has been called a "philosophy of the universe" or its application as "pure science." "The other application includes those commonly called practical, by which food and clothing and dwellings may become readily available to human beings, and by which human health and comfort may be enhanced." He asserts further, "Plant physiology contributes most to human physical welfare in the fields of agriculture, forestry, fermentation operations and bacteriology."

It is the second application that is more in line with the main objective of this Department both in its teaching activity and in research; it is considered by many botanists of practical and utilitarian frame of mind as the most helpful to agriculture. According to Doctor Copeland, "the raising of crops is essentially nothing more or less than applied botany."

The broadest phase of plant physiology and the one most applicable and therefore valuable to agriculture is plant nutrition.

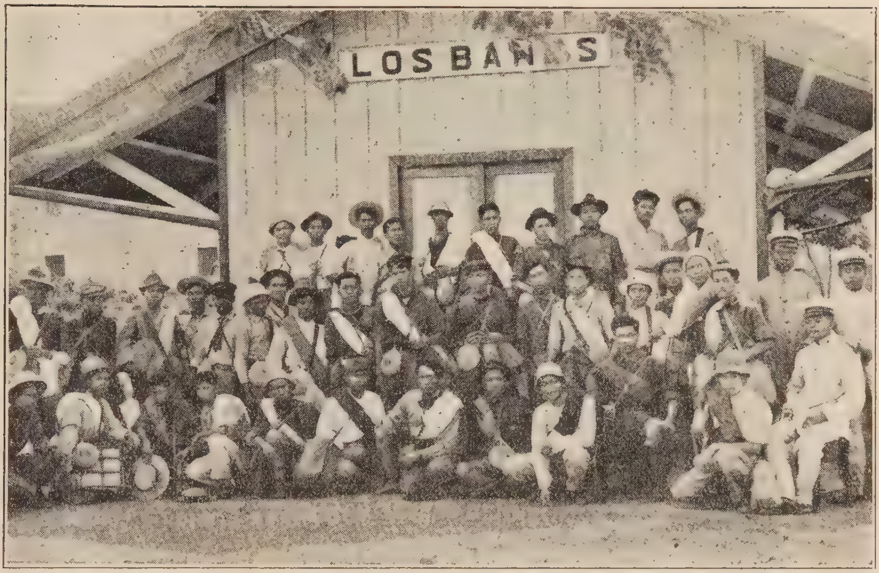
COURSES OF INSTRUCTION

The Department has been offering several botanical courses. Botanical instruction was begun in 1909 by giving two elementary courses, namely, Botany 1 (Elementary Botany) and Botany 2 (Growth and Nutrition). These two courses were again given during the following academic year (1910 1911) but Botany 2 was by that time called Elementary Plant Physiology. In addition, the Department also offered Botany 3 (Plant Nutrition), Botany 4 (Plant Pathology), and Botany 10 (Botanical Research). Practically no change in courses took place the following year, except an additional course of Botany 2a, designed for "students preparing for technical work in forestry and is made up of the subjects fundamental to forest botany, silviculture, and wood technology." No further change in the courses offered in the Department took place until the early part of the academic year 1918–1919 when Botany 4 (Plant Pathology) was transferred to the new Department of Plant Pathology and when for the first time Botany 9 (plant studies, later called special problem) was added to the curriculum of the Department. The Department conducted its teaching work under this program during the next three academic years. In the revision of the curriculum of the College in 1921–1922 more courses were added in that Department. The revised list included thirteen botanical courses, eight of which were newly incorporated. The old courses were the following:

Pl. Physiol. 1 (Elementary Botany).
Pl. Physiol. 2 (Plant Physiology).
Pl. Physiol. 99 (Plant Studies, now called Special Problem).
Pl. Physiol. 100 (Botanical Research, now called Undergraduate Thesis).
Pl. Physiol. 101 (Plant Nutrition).

The new courses were as follows:

Pl. Physiol. 3 (Veterinary Botany).
Pl. Physiol. 102 (Advanced Plant Morphology).
Pl. Physiol. 103 (Short Course in Advanced Morphology, during summer).
Pl. Physiol. 104 (Agricultural Climatology).



Banzon Studio

Botany students on a trip to Mt. Banahao in 1915: a regular feature of botany courses in the earlier days of the College

Pl. Physiol. 199 (Botanical Seminar).
Pl. Physiol. 201 (Botanical Microtechnique).
Pl. Physiol. 202 (Plant Growth and Movement).
Pl. Physiol. 300 (Master's Thesis).

This curriculum, however, was used only during the four succeeding academic years; for, beginning the academic year 1925–1926, all graduate courses in botany, except Pl. Physiol. 300 (Master's Thesis), were suspended; likewise, Pl. Physiol. 102 (Advanced Plant Morphology) and Pl. Physiol. 104 (Agricultural Climatology). The reduction of courses was largely due to lack of sufficient technically trained personnel in the Department and in accordance with the general policy adopted by the College that improvement of the more fundamental courses be attended to first.

During the academic year 1926–1927, permission was granted to the Department to add to its courses two new botanical subjects—Pl. Physiol. 4 (Ecology of Pastures) and Pl. Physiol. 104 (Farm Weeds). But, owing to the departure for the United States of one of the department's trained teachers who was expected to teach the two new courses, these were included in the College catalogue but not actually made available to students. No change of curriculum was made for the academic year 1927–1928, and these courses were again postponed.

However, another revision of the curricula of the College has taken place recently, due to the establishment of a Rural High School. This revision affected the curriculum of the Department of Plant Physiology once more. The abolition of Pl. Physiol. 1 (Elementary Botany) resulted in a material but necessary decrease in enrollment of the Department and was made because of the rapid growth of the College and the much needed readjustment of courses in the College to suit existing conditions. Except for a few old students who are enrolled in the College under the Preparatory Curriculum, and who had earned credits in other subjects but lack credits in Pl. Physiol. 1 (Elementary Botany), this course would not have been given this year.

Effective at the beginning of the academic year 1929–1930, the courses given in the Department are as follows:

Pl. Physiol. 1 (Plant Physiology).
Pl. Physiol. 2 (Advanced Morphology).
Pl. Physiol. 3 (Veterinary Botany).
Pl. Physiol. 4 (Ecology of Pastures).
Pl. Physiol. 99 (Special Problems in Plant Physiology).
Pl. Physiol. 100 (Undergraduate Thesis in Plant Physiology).
Pl. Physiol. 101 (Plant Nutrition).
Pl. Physiol. 104 (Farm Weeds).
Pl. Physiol. 199 (Seminar in Plant Physiology).
Pl. Physiol. 300 (Master's Thesis in Plant Physiology).

Due to lack of sufficient teaching force and the fact that instruction in Agronomy 15 and 16 (abaca and coconut) are at present given by the Department of Plant Physiology in coöperation with the Department of Agronomy, the courses Pl. Physiol. 2, 4, and 104 are not offered during the academic year 1929–1930.

The enrollment in the Department of Plant Physiology started with 43 students in 1909–1910 and mounted rather rapidly every year to 334 students during the academic year 1917–1918. However, owing to the enlistment of our students in the Philippine National Guard, the enrollment for the following year went down to 122 students. It steadily rose again every year thereafter until it reached the highest peak in the academic year 1928–1929, with an enrollment of 550 students. During the period of twenty years, the Department of Plant Physiology has had enrolled, in its different courses, nearly 5,000 students or an average of about 255 students a year.

RESEARCHES AND PERSONNEL

Researches were conducted both by the Department staff members and by students who were majoring in the Department, which has to its credit 171 technical contributions to the science of botany, or an average of eight and a half papers a year. The papers that have been published by the Department are in the majority of cases of practical usefulness to Philippine agriculture.

The establishment and formative stage of the Department of Plant Physiology took place under Doctor Copeland. His term lasted about eight years. Principally associated with Doctor Copeland in the conduct of the Department in the earlier days were Mr. R. M. Holman, at present a professor of botany in the University of California, Dr. F. C. Gates, Dr. F. T. McLean and Mr. R. B. Espino. In addition to these men, Doctor Copeland almost every summer secured the services of Dr. Wm. H. Brown, then connected with the Bureaus of Forestry and Science, and at present Director of the Bureau of Science, in teaching elementary botany. In charge of the plant pathology class of the Department, prior to the coming of Professor Otto A. Reinking, was the late Dean Baker. Upon the arrival of Professor Reinking, however, the class was turned over to him and the direct connection of Professor Baker with the Department was completely severed. Mr. K. Duncan also served the Department as teacher in botany for one year, June 10, 1912, to June 14, 1913.

The herbarium of the Department, which contains no less than 20,000 sheets of herbarium specimens, each properly mounted, labelled and named, was established by Doctor Copeland, who collected and prepared many of the specimens. However, a great deal of work was devoted to the herbarium by Dr. F. C. Gates, who, during his two years' connection with the Department, increased the herbarium to almost the present size. Many specimens, especially of the lower forms of plants, were donations from the late Dean Baker.

During Doctor Copeland's time, studies on growth and transpiration received particularly careful attention. Measurements on plant growth "required of each student is approximately 3,000." "A thorough first-hand idea of the growth of a variety of plants and of different parts of plants under various treatments" was expected of each student. This phase of study was so extensive that it even included weekly and monthly observation for a period of one year on plants growing at the summit of Mount Maquiling.

Botanical excursions to Mount Maquiling and to Mount Banahao were made by the members of the first two courses in botany. These excursions were almost always led by Doctor Copeland himself. From these excursions students developed endurance, saw new regions and vegetation and acquired first-hand knowledge of the response of different kinds of plants to their respective environments.

Dr. F. T. McLean served the Department for about six years, beginning October 6, 1915. Upon the retirement of Doctor Copeland on September 1, 1917, Doctor McLean assumed the headship of the Department, which position he held until his resignation on August 18, 1921.

Associated with Professor McLean in the conduct of the Department were Assistant Professor Sam F. Trelease and Assistants E. Quisumbing and G. O. Ocfemia. In June, 1918, after serving the Department about one year, Mr. Ocfemia was transferred to the new Department of Plant Pathology. In August, 1920, Assistant Quisumbing was sent to the United States as a pensionado in botany. He came back sometime in 1923. Mr. N. Catalan, a graduate of the College, was at about this time an assistant in the Department, helping in the conduct of the laboratory work in Plant Physiology 1 (Elementary Botany). Mr. F. de Peralta was also serving the Department.

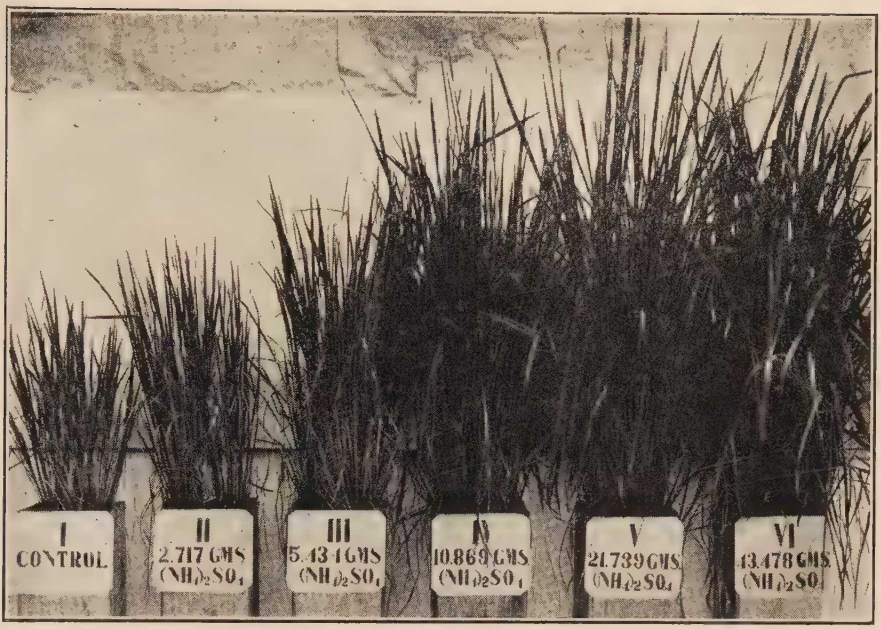
Doctor McLean followed the policy of Doctor Copeland, particularly in regard to teaching. The first two fundamental courses were given as before, and studies on growth of plants and on methods of measuring growth of plants similarly emphasized. Transpiration and transpiring power of leaves of plants were carefully studied. Photosynthesis also received due attention, the leaves of sugar cane being particularly studied.

The outstanding accomplishment of the Department during this term was in the form of manuals written by Assistant Professor Trelease for use in his classes. Doctor Trelease carefully revised and amplified *The First Year in Botany* by Doctor Copeland (multigraphed by the College of Agriculture). He also wrote and published an excellent direction of laboratory work in Plant Physiology 1 (Elementary Botany) entitled *Laboratory Exercises in Agricultural Botany*, and in joint authorship with Professor Emma S. Yule published *Preparation of Scientific and Technical Papers.* The valuable services of Professor Trelease to the Department which began on August 25, 1917, were cut short by his resignation sometime in 1920.

Associate Professor F. P. McWhorter was acting head of the Department during a brief period of less than one year, between the resignation of Professor McLean and the arrival from Australia of Professor D. A. Herbert, who was head from February 14, 1922, to September 30, 1924. In handling the work of the Department, Professor Herbert was assisted by Doctor Quisumbing, who took charge of the class in elementary botany and of the herbarium. He was also assisted in the laboratory by Instructor Peralta, Assistants Estioko, Manza, and Juliano. On account of the shortness of Professor Herbert's term of office, he could not plan out a series of long-time experiments. He, therefore, confined his research work and that of his thesis students to problems that could be worked out in a rather brief period of time. Consequently, the major research activity during his time was investigation on the alleged poisonous plants. He and his students worked also on parasitism, irritability and on germination of farm seeds as influenced by anaesthetics. His stay in the Department, therefore, proved more profitable to animal husbandry and veterinary courses and professions and to the science of botany in general than to plant industry.

Upon the resignation of Professor Herbert, Doctor Espino, who had been detailed for five years to the Department of Agronomy to take charge of the work on abaca and coconut, was appointed acting head on October 1, 1924.

As has always been the policy, the major work of the Department during the incumbency of Professor Espino as head is teaching. No effort is spared to make the courses of instruction as thorough and as up to date as



Plant nutrition studies are emphasized in the present courses in plant physiology

possible. And, owing to lack of textbooks suitable for the needs of the students of the Department, Doctor Espino has prepared and mimeographed the following for the use of his classes:

1. Plant Physiology: A Course Fundamental to Agronomy.
2. Directions for Experiments in Plant Physiology 2.

Believing that most of the problems that confront farmers in the Philippines are on how plants live and provide themselves with food, and knowing that the use of fertilizers and manures is being rapidly recognized by Filipino farmers as an effective means of increasing the yield of their crops, the Department is at present devoting special attention to plant nutrition, particularly on mineral requirements of plants. This plan is being carried out both in class room and in research. Most of the scientific contributions of the Department are on the salt requirements of the rice plant. The Department gives attention also to the study of sugar cane, tobacco and cogon plants as influenced by their environment. The investigational work is done largely by the thesis students, but partly by the members of the Department.

DEPARTMENT OF RURAL ECONOMICS

PABLO N. MABBUN
Instructor in Rural Economics

The Department of Rural Economics was organized in June, 1919, when Mr. Evett D. Hester, formerly principal teacher of the Provincial High School of La Union, was appointed associate professor of economics in the College.

When Professor Hester assumed his duties, he immediately made plans to re-establish the courses in principles of rural economics and in farm accounting, which had been given during the school year 1917—18 by Messrs. Mariano B. Raymundo and José Dacanay, but subsequently had been suspended temporarily. He had with him as his assistant Mr. Juan P. Torres, a recent graduate of the College. Mr. Torres, however, did not finish the school year; he resigned to accept an appointment in the Bureau of Agriculture. Professor Hester was then left alone to handle the two economics courses until the end of the academic year. Despite this handicap, Professor Hester managed to keep alive the enthusiasm of his students in the courses; and this year marked the beginning of the steady development of courses in the Rural Economics Department.

As the Department progressed, there was need of other men to help Professor Hester. After Mr. Torres left, Professor Hester had to employ students to assist him in teaching. In July, 1921, Mr. Lorenzo Goco, who had been one of the student assistants and who had recently been graduated, was appointed graduate assistant to teach classes in farm accounting. Professor Hester evidently observed after two years' experience in teaching in the College that the students could not very well understand the subject matter in rural economy without a good background in fundamental principles, such as those taught to students in our public high schools, so he decided to offer a course in economic conditions of the Philippines. This course was designated as Rural Economics 1, while the old Rural Economics 1 became Rural Economics 2, and Farm Accounting, Rural Economics 3. With the help of Mr. Goco, Professor Hester made simplifications in business accounting methods so as to adapt them to the needs of the farm.

The introduction of the new course in economic conditions of the Philippines made the appointment of an instructor imperative. Professor Hester had a hard time finding a man that could satisfy the requirements. He finally succeeded in securing the appointment as instructor in economics of Mr. José E. Velmonte, a 1921 honor graduate of commerce in the University of the Philippines. Mr. Velmonte was assigned to teach the new course when he reported for duty on June 29, 1922. Since that time he taught that subject until it was eliminated from the recently revised curricula of the College beginning with the year 1929–30.

The appointment of Mr. Velmonte enabled Professor Hester to add one more course to those already given. This new course was designated as Rural Economics 4 (Rural Co-operation and Credits). It was managed by Professor Hester.

The number of students enrolled in the different courses offered by the Department continued to increase so that there was need of appointing another assistant. Moreover, there was the added burden to the already crowded daily program of Professor Hester, as he was also registrar of the College, and beside that, the former Department of History was placed under the Department of Rural Economics for purposes of administration. Mr. Pablo N. Mabbun, a 1923 honor graduate of the College, was accordingly appointed assistant in rural economics on April 5, 1923. He was assigned to assist Professor Hester in teaching Rural Economics 2 and to help him in conducting research work.

Since the academic year 1924–25, there has been an annual turnover in the personnel of the Department, due either to temporary leave or resignation of members of the staff. Mr. Mabbun resigned on July 31, 1924, to accept a position as instructor of biology in the Cagayan High School. Mr. Teodosio Buenaventura, a graduate of law, University of Southern California, was appointed instructor in history to take the place vacated by Mr. Ricardo Avila, who had resigned after serving a short term. Mr. Buenaventura is still teaching classes in history during the present school year (1929—30) with the additional assignment since 1927—28 as instructor in Spanish. Mr. Mariano C. Lopez, a graduate of Georgetown University and of the American University, was appointed assistant professor in economics. On May 3, 1925, Professor Hester resigned and Professor Lopez was appointed acting head of the Department. Professor Lopez continued to follow the same policies and the same objectives laid down by Professor Hester. This was evident from the fact that there were no changes made in the assignments of the members of the staff and in most of the courses taught. The only course which received, not necessarily changes, but further simplification to suit changing needs, was the farm accounting course. This simplification was made by Professor Lopez and Mr. Francisco M. Sacay, the latter having been appointed assistant in economics to take the place of Mr. Goco, who had resigned on March 16, 1925. Mr. Sacay was a 1925 honor graduate of the College. He has done much to improve the farm accounting course in the Department.

The resignation of Professor Hester made the appointment of another instructor necessary and urgent. Mr. Mabbun was reinstated as instructor in rural economics effective July 2, 1925. His chief assignment was to teach

Rural Economics 4 and Rural Economics 5. The latter was a new course which was opened to fill the needs of students who were taking Sugar Technology. Both these courses had been taught by Professor Hester before he left.

During the school year 1928–29, Mr. R. B. Rotor, of the Class of 1928 of the College, was appointed assistant in economics to take the place vacated by Mr. Sacay, who sailed for the United States as a University fellow in Agricultural Education. Professor M. B. Raymundo, of the Department of Agronomy, was temporarily put in charge of the Department of Rural Economics and assigned the subjects taught by Professor Lopez, who was on leave during the greater part of the first semester. During the second semester Professor Lopez recovered from his illness and was able to take his class. A new course, Rural Economics 6 (Marketing of Farm Products), was also offered for the first time. Professor Lopez went on extended leave of absence beginning January 16, 1929. The departure of Professor Lopez crowded the work of the Department on those who were left behind, as there was no one appointed to fill the place left vacant.

During the summer of 1928–29, Mr. Velmonte taught Rural Economics 1 for the last time. Changes in the curricula of the College eliminated this course and in order to accommodate those students who had no chance to take it during the last school year, it was opened during the summer. The elimination of Economic Conditions of the Philippines from the list of courses offered by the Department necessarily introduced changes in the designation of some of the remaining courses.

Mr. Velmonte, who is at present in charge of the Department, is following the same policies as originally outlined by its founder. No changes in assignments of the members of the staff were made. Mr. Marcelo V. Arnaldo, a 1927 graduate of the College, was appointed assistant in economics by transfer from the Bureau of Agriculture, effective June 5, 1929. He is now helping Mr. Rotor to teach classes in Rural Economics 1.

Besides the courses already mentioned, the Department offers Rural Economics 99, 100, and 199 to students majoring in Rural Economics. Members of the staff of the Department from the rank of instructor and up have been handling these courses in the capacity of advisers.

The following table is given in order to show the growth of the Department:

YEAR	NO. COURSES	TOTAL NO. STUDENTS ENROLLED IN ECONOMICS	TOTAL NO. STUDENTS ENROLLED IN HISTORY	TOTAL NO. STUDENTS	NO. OF MEMBERS OF STAFF
1919–1920	2	252	—	252	2
1920–1921	4	191	—	191	1
1921–1922	5	256	—	256	2
1922–1923	6	501	—	501	3
1923–1924	10	334	40	374	5
1924–1925	11	336	68	404	4
1925–1926	11	446	54	500	5
1926–1927	11	405	35	440	5
1927–1928	11	470	36	506	5
1928–1929	13	643	49	692	5
1929–1930	13	476*	25	501	5

*This number represents only the enrollment in the courses during the first semester of the school year 1929–1930.

Research work touching on economic and social problems in the Philippines has been undertaken by certain members of the staff of the Department. A comprehensive study of Philippine tenancies was made by Professor Hester and Mr. Mabbun, the results of which were embodied in a paper published in the *Philippine Agriculturist.* Several other papers were prepared by Professor Hester on Philippine production of different major crops, such as sugar, rice, and rubber, and on problems of current economic interest. These papers were published either in the *Philippine Agriculturist* or in some of the Manila weeklies. Mr. Sacay prepared a paper which was published as Circular No. 16. This was designed to acquaint our farmers with the most easily and readily understood methods of keeping accounts on the farm. Other works on cost of production of rice in the provinces of Central Luzon and on some problems confronting tenants in Bulacan were also prepared and published by Mr. Sacay. Mr. Velmonte conducted research work touching on problems of capital investments in our agriculture and land taxation in the Philippines. Mr. Mabbun conducted an investigation on methods of marketing tobacco and problems confronting our tobacco farmers. Other agricultural labor problems and workings of the Rural Co-operative Credit Associations were studied by Mr. Mabbun.

In addition, certain members of the staff conducted investigations on various social and economic problems of current interest in conjunction with other departments of the College or with students majoring in economics.

The Department has always been co-operating with various entities of the College in the way of auditing financial books, such as accounts of the Agronomy Department, the College Mess Hall, the College Co-operative Co., Inc., the Cine Maquiling Co., and other local concerns.

DETERMINATION OF AGE OF WATER BUFFALOES BY THE ERUPTION OF TEMPORARY AND PERMANENT INCISORS[1]

VALENTE VILLEGAS
Of the Department of Animal Husbandry

WITH ONE TEXT FIGURE

The age of animals determines the length of time they may be useful for breeding or other purposes. Age also influences the quality of meat in butcher stock. Consequently, the monetary value of an animal depends in some degree on its age.

The changes occurring in the temporary and permanent incisors of an animal up to maturity affords a fairly accurate means of determining its age. The present work was conducted to cover this phase of the subject among water buffaloes.

In regard to the determination of age by the teeth, Levine (1919)[2] makes the following remarks: "The calf is usually born with six temporary teeth in the front of the lower jaw. Two more appear a few weeks later. At about three years of age the middle pair of the temporary teeth are replaced by two permanent teeth. At four years the teeth on either side of the first pair are up and in use. At five years the next teeth on either side of the fourth-year teeth are up, and at six years the corner teeth are up and in wear." Whether these statements are founded on observations or on opinion is not stated.

Specifically, the object of this investigation is to determine the age of water buffaloes at the time the deciduous or temporary incisors erupt and when they are replaced by permanent teeth. The work was conducted at the College of Agriculture, University of the Philippines, from November 18, 1924, to February 23, 1929.

ANIMALS

Altogether there were 55 animals observed of which 21 were carabaos, 13 Indian buffaloes, and 21 Indian buffalo grades. All animals of known age in the College herds of which the teeth had not completely erupted were included in this study. There were animals which either died or were disposed of before determinations on their dentition were concluded, so that data for some individuals could not be completed. Records as to date of birth, sex, and breeding of each of the animals included in this work are shown in table 1. The grades were all crossbreeds, with the exception of those with herd numbers 37, 43, 48, 58, 70, which have three-fourth Indian buffalo blood and one-fourth native; herd numbers 56, 63, 67, with three-fourth native and one-fourth Indian buffalo; and herd number 69 which is seven-eighth Indian buffalo and one-eighth native.

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[1] Experiment Station contribution No. 615. Read before Los Baños Biological Club July 2, 1929. Received for publication July 3, 1929.

[2] Levine, Carl Oscar. 1919. Notes on farm animals and animal industries in China. Canton Christian College Bulletin 23: 1–54. *Plates 1 to 4.*

Thirty-nine animals were observed for the eruption of the deciduous incisors and twenty-three for the replacement of temporary incisors by permanent teeth.

MANAGEMENT

Practically all cows which freshened during the period covered by the present work were used as dairy animals. They were brought into the dairy barn twice a day to be milked both in the morning or in the afternoon. Between milking times they were turned loose in the pasture to graze. In the barn they received mixtures of grain corresponding to the amount and quality of milk each animal gave. Unweaned calves were kept in the barn for about twelve hours previous to the milking of the mothers while the rest of the time they went with their dams. In the barn these calves were fed soilage and concentrates.

As soon as the calves were weaned they were classified into males and females and placed in separate corrals to prevent interbreeding. The males were kept in the pastures at all times while the females were brought back to the dairy herd as soon as they calved.

PROCEDURE

The determination of the eruption of temporary incisors was made by examining the mouth of the calves weekly. With the permanent teeth, observations of the mouth were made monthly.

By their larger size the permanent teeth are easily distinguished from the deciduous incisors. (See fig. 1c.) Besides, at the beginning deciduous incisors are whiter and smoother than the permanent members. With both sets of teeth, however, the color darkens as the teeth become older due to the accumulation of extraneous matter on the surface of the enamel.

DISCUSSION OF RESULTS

THE ERUPTION OF DECIDUOUS INCISORS

First pair

As may be seen in table 2, two of the carabao calves showed the first pair of deciduous incisors at birth and one calf at 1 day of age so that the average age at the time of eruption is $^1/_3$ day. With Indian buffaloes, the age at the time of eruption varied from 1 day to 8 days, with an average of $3\,^4/_5$ days. Among the grades, two calves had the first pair of incisors at birth while one calf showed eruption at the age of 9 days, the average being $3\,^5/_{12}$ days.

Taking all the water buffaloes together, the average age at the time of eruption of the first pair of deciduous incisors was $3\,^{1}/_{20}$ days.

Second pair

With carabaos, the second pair of deciduous incisors appeared in one calf at birth and in two animals at the age of 9 days. In one calf the age at the time of eruption was 6 days. The average age was $5\,^{3}/_{4}$ days. The range in age among the Indian buffaloes was from 1 day to 31 days, the average being $11\,^{1}/_{3}$ days. The earliest eruption in the grades was at the age of 3 days and the latest at the age of 25 days. The average age was $13\,^{1}/_{3}$ days.

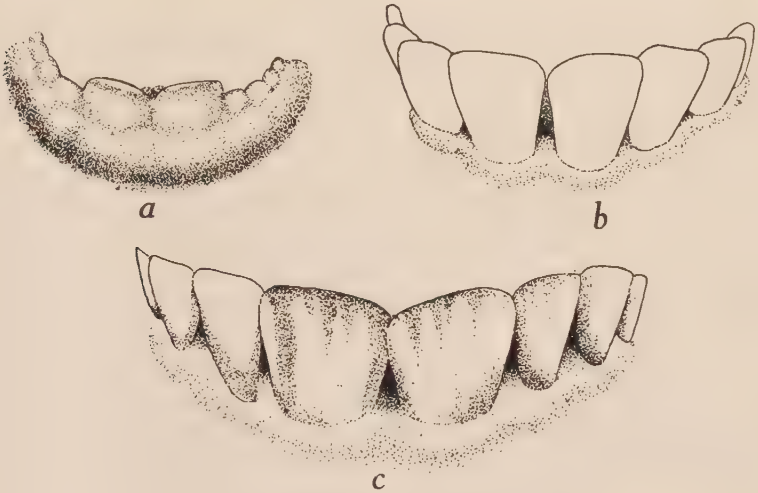

Fig. 1.—Development of Incisors in Water Buffaloes

a. Corpus mandibulae of a water buffalo calf at birth

b. A complete set of fully-grown deciduous incisors of water buffalo

c. Showing the size of middle pair of permanent incisors of water buffalo in relation to that of deciduous pairs

The average age at the time the second pair of deciduous incisors appeared in all water buffaloes studied was $11\,^{8}/_{23}$ days.

Third pair

One calf among the carabaos showed the third pair of deciduous incisors at birth, while the oldest animal erupted its pair at the age of 1 month and 2 days. The average age was $14\,^{1}/_{3}$ days. In the case of Indian buffaloes the age at the time the third pair of deciduous incisors erupted varied from 5 days to 1 month and 1 day, the average being $19\,^{5}/_{7}$ days. With the grades the range was from 7 days to 1 month and 8 days, the average age being $20\,^{4}/_{13}$ days.

Considering all the water buffaloes, the average age at the time the third pair of deciduous incisors appeared was $18\,{}^{10}/_{13}$ days.

Fourth pair

The range in age when the fourth pair of deciduous incisors made their appearance in carabaos was from 1 month and 3 days to 6 months and 9 days, the average being 3 months and 20.4 days. With Indian buffaloes the earliest time these incisors showed was at the age of 3 months and 26 days, and the latest at the age of 5 months and 3 days, the average age for all being 4 months and $11\,{}^{3}/_{5}$ days. The variation among the grades was from the age of 1 month and 7 days to 11 months. The average age for all grades was 4 months and $27\,{}^{1}/_{14}$ days.

The average age when the fourth pair of deciduous incisors erupted in all water buffaloes was 4 months and $11\,{}^{22}/_{29}$ days.

THE ERUPTION OF PERMANENT INCISORS

First pair

As shown in table 3, the first pair of permanent incisors erupted from the age of 2 years, 7 months, and 25 days to the age of 3 years, 3 months, and 20 days among carabaos. The average age when eruption took place was 2 years, 10 months, and $16\,{}^{1}/_{6}$ days. With the Indian buffaloes, the average age was 2 years, 10 months, and $10\,{}^{3}/_{5}$ days, the range being from the age of 2 years, 9 months, and 17 days to 2 years, 11 months, and 18 days. Among the grades, the youngest age at which the first pair of permanent incisors appeared was 2 years, 8 months, and 10 days, and the latest at the age of 3 years, 2 months, and 25 days, the average being 2 years, 11 months, and $21\,{}^{2}/_{5}$ days.

All water buffaloes taken together gave an average age of 2 years, 10 months, and $25\,{}^{7}/_{6}$ days at which the first pair of permanent incisors erupted.

Second pair

With carabaos, the age at which the second pair of permanent incisors appeared varied from 3 years, 1 month, and 1 day to 4 years, 1 month, and 29 days. The average age was 3 years, 4 months and $7\,{}^{3}/_{4}$ days. In the case of Indian buffaloes, the youngest animal erupted the second pair of permanent incisors at the age of 3 years, 5 months, and 19 days, while in the oldest these teeth showed at the age of 3 years, 7 months, the average age being 3 years, 6 months, $10\,{}^{1}/_{2}$ days. The variation in age among the grades was from 3 years, 8 months, and 17 days to 3 years, 9 months, and 4 days; the average being 3 years, 8 months, and $27\,{}^{1}/_{3}$ days.

The average age when the second pair of permanent incisors erupted in all the animals studied was 3 years, 5 months, $22\,{}^{6}/_{15}$ days.

Third pair

The youngest carabao showed its third pair of permanent incisors at the age of 3 years, 6 months, 7 days, and the oldest at the age of 5 years and 27 days, the average age being 4 years, 1 month, and $24\,^{3}/_{7}$ days. With Indian buffaloes, the range was from 3 years, 10 months, and 20 days to 4 years, 5 months, and 16 days, giving an average age of 4 years, 3 months, and $20\,^{1}/_{4}$ days. The grades showed a variation in age of from 4 years, 4 months, and 5 days to 4 years, 11 months, and 16 days, the average being 4 years, 8 months, and $10\,^{1}/_{3}$ days.

The average age at which the third pair of permanent incisors appeared in all the water buffaloes was 4 years, 3 months, $22\,^{5}/_{14}$ days.

Fourth pair

With carabaos, the age at which the youngest animal showed the first pair of permanent incisors was 4 years, 1 month, and 15 days, while the maximum age was 5 years, 5 months, and 27 days, giving an average age of 4 years, 7 months, and 16 days. In the case of Indian buffaloes, the variation was from the age of 4 years, 6 months, and 4 days to 5 years, and 18 days, the average age being 4 years, 9 months, and $18\,^{3}/_{4}$ days. There was only one grade showing the eruption of the fourth pair of its permanent incisors which took place at the age of 5 years, 9 months, and 2 days.

In all the water buffaloes the average age at which the fourth pair of permanent incisors erupted was 4 years, 10 months, and $8\,^{1}/_{8}$ days.

CONCLUSIONS

From observations on 39 water buffaloes the average age of animals at which the different pairs of deciduous incisors erupted are as follows:

Deciduous incisors	*Age*
First pair	3+ days
Second pair	11+ days
Third pair	18+ days
Fourth pair	4 months, 11+ days

From a study of the dentition of 23 water buffaloes, the average age at which replacement of the different pairs of deciduous incisors by permanent teeth took place as follows:

Permanent incisors	*Age*
First pair	2 years, 10 months, 25+ days
Second pair	3 years, 5 months, 22+ days
Third pair	4 years, 3 months, 22+ days
Fourth pair	4 years, 10 months, 8+ days

TABLE 1

Breeding, sex, and dates of birth of water buffaloes

NATIVE			INDIAN BUFFALO			GRADE		
H. No.	Sex	Date of birth	H. No.	Sex	Date of birth	H. No.	Sex	Date of birth
17	♂	19– IX–'20	7	♀	11– VII–'21	21	♀	9– IX–'21
18	♀	24– X–'20	8	♂	1– IX–'21	29	♀	27– XI–'22
22	♀	29– X–'21	10	♀	22– XI–'22	36	♀	1–VIII–'24
23	♂	1– XI–'21	11	♀	17– XII–'22	37	♂	11– XI–'24
25	♀	6– II–'22	15	♀	18– III–'25	38	♀	11– XII–'24
27	♂	2– IV–'22	16	♀	26– X–'25	41	♂	26– VI–'25
30	♂	11– XII–'22	17	♂	7– XII–'25	42	♂	12– X–'25
31	♀	17– XII–'22	18	♀	19– XII–'25	43	♀	22– X–'25
32	♀	9– II–'23	19	♂	14– IX–'27	44	♀	6– I–'26
39	♀	9– V–'25	20	♂	9– X–'27	48	♂	10– VII–'26
40	♀	5– VI–'25	21	♂	18– X–'27	50	♂	26– X–'26
45	♀	28– V–'26	22	♂	3– XII–'28	56	♀	4–VIII–'27
46	♀	29– V–'26	23	♂	11– I–'29	58	♂	17– IX–'27
47	♀	5– VI–'26				59	♀	14– X–'27
49	♂	7–VIII–'26				60	♀	29– X–'27
51	♂	1– XI–'26				61	♂	8– III–'28
53	♂	13– III–'27				62	♂	18– VII–'28
57	♂	22–VIII–'27				63	♀	2–VIII–'28
64	♀	28–VIII–'28				67	♂	29– X–'28
66	♂	16– X–'28				69	♂	13– II–'29
68	♂	30– X–'28				70	♂	5– III–'29

TABLE 2

Age of animals at time of eruption of deciduous incisors

H. NO.	FIRST PAIR	SECOND PAIR	THIRD PAIR	FOURTH PAIR
Carabaos				
39	——	9 da.	21 da.	4 mo., 4 da.
40	——	——	18 da.	——
45	1 da.	——	——	6 mo., 9 da.
46	at birth	——	——	——
47	——	——	——	6 mo., 2 da.
49	——	——	——	4 mo., 7 da.
51	——	——	——	1 mo., 27 da.
53	——	——	——	3 mo., 19 da.
57	——	6 da.	1 mo., 2 da.	2 mo., 30 da.
64	——	9 da.	11 da.	2 mo., 6 da.
66	——	——	4 da.	4 mo., 7 da.
68	at birth	at birth	at birth	1 mo., 3 da.
Average.....	⅓ da.	5¾ da.	14⅓ da.	3 mo., 20.4 da.
Indian buffaloes				
15	——	——	——	3 mo., 26 da.
17	8 da.	8 da.	22 da.	——
18	——	——	17 da.	5 mo., 3 da.
19	3 da.	1 mo., 1 da.	1 mo., 1 da.	4 mo., 15 da.
20	6 da.	6 da.	28 da.	3 mo., 28 da.
21	1 da.	6 da.	13 da.	4 mo., 16 da.
22	——	1 da.	5 da.	——
23	1 da.	16 da.	22 da.	——
Average.....	$3^{4}/_{5}$ da.	11⅓ da	$19^{5}/_{7}$ da.	4 mo., $11^{3}/_{5}$ da.
Indian buffalo grades				
36	——	——	——	4 mo.
37	——	——	7 da.	——
38	——	12 da.	19 da.	3 mo., 13 da.
41	1 da.	11 da.	25 da.	5 mo., 19 da.
42	8 da.	8 da.	15 da.	2 mo., 20 da.
43	5 da.	11 da.	19 da.	9 mo., 2 da.
44	9 da.	17 da.	——	6 mo., 18 da.
48	——	——	——	5 mo., 11 da.
50	——	——	——	2 mo., 2 da.
56	——	——	10 da.	2 mo., 13 da.
58	at birth	——	1 mo.	1 mo., 7 da.
59	3 da.	3 da.	17 da.	3 mo., 9 da.
60	2 da.	8 da.	16 da.	5 mo., 4 da.
61	5 da.	25 da.	1 mo., 8 da.	11 mo.
62	3 da.	24 da.	——	——
63	2 da.	9 da.	23 da.	6 mo., 21 da.
67	——	7 da.	21 da.	——
69	3 da.	24 da.	24 da.	——
70	at birth	11 da.	——	——
Average.....	$3^{5}/_{12}$ da.	$13^{1}/_{13}$ da.	$20^{4}/_{13}$ da.	4 mo., $27^{1}/_{4}$ da.
Gen. Average.	$3^{1}/_{20}$ da.	$11^{8}/_{23}$ da.	$18^{20}/_{26}$ da.	4 mo. $11^{22}/_{29}$ da.

TABLE 3

Age of animals at time of eruption of permanent incisors

Carabaos

H. NO.	FIRST PAIR	SECOND PAIR	THIRD PAIR	FOURTH PAIR
17	———	4 yr., 1 mo., 29 da.	4 yr., 2 mo., 20 da.	———
18	———	———	4 yr., 24 da.	4 yr., 1 mo., 15 da.
22	———	3 yr., 5 mo., 23 da.	3 yr., 6 mo., 7 da.	———
23	———	3 yr., 1 mo., 1 da.	3 yr., 7 mo., 22 da.	4 yr., 3 mo., 6 da.
25	3 yr., 1 mo., 4 da.	———	———	———
27	2 yr., 9 mo., 4 da.	3 yr., 3 mo., 19 da.	4 yr., 15 da.	———
30	2 yr., 8 mo., 14 da.	2 yr., 8 mo., 28 da.	4 yr., 5 mo., 26 da.	5 yr., 5 mo., 27 da.
31	2 yr., 7 mo., 25 da.	3 yr., 3 mo., 10 da.	———	———
32	3 yr., 3 mo., 20 da.	3 yr., 4 mo., 10 da.	5 yr., 27 da.	———
39	2 yr., 9 mo.	3 yr., 5 mo., 2 da.	———	———
Average.	2 yr., 10 mo., 16 1/6 da.	3 yr., 4 mo., 7 3/4 da.	4 yr., 1 mo., 24 3/7 da.	4 yr., 7 mo., 16 da.

Indian buffaloes

7	———	3 yr., 6 mo., 9 da.	4 yr., 5 mo., 4 da.	4 yr., 6 mo., 4 da.
8	———	———	3 yr., 10 mo., 20 da.	4 yr., 8 mo.
10	2 yr., 10 mo., 11 da.	3 yr., 6 mo., 14 da.	4 yr., 5 mo., 16 da.	5 yr., 18 da.
11	2 yr., 9 mo., 26 da.	3 yr., 7 mo.	4 yr., 5 mo., 11 da.	4 yr., 11 mo., 23 da.
15	2 yr., 11 mo., 18 da.	3 yr., 5 mo., 19 da.	———	———
16	2 yr., 10 mo., 11 da.	———	———	———
18	2 yr., 9 mo., 17 da.	———	———	———
Average.	2 yr., 10 mo., 10 3/5 da.	3 yr., 6 mo., 10 1/2 da.	4 yr., 3 mo., 20 1/4 da.	4 yr., 9 mo., 18 3/4 da.

Indian buffalo grades

21	———	3 yr., 8 mo., 17 da.	4 yr., 9 mo., 10 da.	5 yr., 9 mo., 2 da.
29	3 yr., 1 mo., 2 da.	3 yr., 9 mo., 1 da.	4 yr., 11 mo., 16 da.	———
36	2 yr., 10 mo., 10 da.	3 yr., 9 mo., 4 da.	4 yr., 4 mo., 5 da.	———
38	3 yr., 2 mo., 25 da.	———	———	———
41	2 yr., 8 mo., 10 da.	———	———	———
44	3 yr.	———	———	———
Average.	2 yr., 11 mo., 21 2/5 da.	3 yr., 8 mo., 27 1/3 da.	4 yr., 8 mo., 10 1/3 da.	5 yr., 9 mo., 2 da.
General Average.	2 yr., 10 mo., 25 7/16 da.	3 yr., 5 mo., 22 6/15 da.	4 yr., 3 mo., 22 5/14 da.	4 yr., 10 mo., 8 1/8 da.

SOME PRELIMINARY STUDIES ON ETHER-EXTRACT DETERMINATION[1]

F. T. ADRIANO AND L. A. YNALVEZ

WITH ONE TEXT FIGURE

One of the most important constituents which is determined in the proximate analysis of foods and feeding stuffs is crude fats, or ether extract. The determination requires a special and expensive set of Soxhlet's extraction apparatus. Usually the amount of crude fats is taken as the weight of the ether extract obtained in the extraction flask after it has been dried to constant weight in an oven. Another method of determining the ether extract is from the loss in weight of the dried sample after it has been subjected to a certain period of extraction, and then drying the ether-extracted sample in an oven to constant weight. The latter method is more convenient to carry out than the former. So far as the writer is aware, no studies on the latter method have been carried out. However, as regards modification of the Soxhlet's apparatus itself, many publications are now recorded in literature.

The usual forms of Soxhlet's extraction apparatus are costly. In addition, the apparatus consists of several fragile parts provided with ground joints. If any of these parts should break, replacement is difficult, on account of the distance from the manufactory. It is, therefore, desirable to have an extraction apparatus that can be made of common and cheap laboratory equipment.

Objects of the present work

The objects of the present study may be divided into two parts: 1. To determine the comparative amount of ether extract obtained from the loss in weight of sample in the thimble and the oil recovered in the extraction flask. 2. To devise a cheap and easily constructed ether-extraction apparatus.

MATERIALS

For this study a set of Cavannaugh's modified Soxhlet's apparatus, twelve in a set, was used. For the improvised extraction apparatus, a 250-cc. Erlenmeyer flask was used in place of the Soxhlet's extraction flask. It was fitted with a cork through which was passed a Liebig condenser.

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[1] Experiment Station contribution No. 624.

Solvent

Anhydrous ether distilled over sodium was used throughout the experiment.

Sample

The samples used are given in table 1.

Solutions

a. Tenth normal sodium thiosulfate solution, prepared and standardized by pure copper foil in the usual way.

b. Iodine monobromide, prepared by dissolving 13 grams of pure iodine crystals in 850 cc. of glacial acetic acid. The calculated amount of bromine water was added to the above solution so as to double the halogen number (Hanus iodine solution).

c. Freshly prepared 15 per cent potassium iodide solution, made by dissolving 15 grams of pure crystals of the salt in 100 cc. of solution.

d. Starch paste, prepared by taking one gram of corn starch and adding to it a small amount of water so as to form a thin paste. This was then poured into 100 cc. boiling distilled water and the heating continued for a few more seconds.

PROCEDURE

Comparison between the amount of ether extract obtained from the extraction flask and from the loss of weight of the sample

The sample was placed in fat-free extraction thimbles and weighed by difference. It was then placed in an oven kept at 100°C. until it no longer lost weight. The thimble containing the moisture-free sample was placed in the extraction chamber of the Soxhlet's apparatus. A tared extraction flask was then connected to the lower part of the extraction apparatus. Sufficient amount of anhydrous ether was poured into the extraction flask and ether extraction performed for 25 hours. After the extraction period the thimble containing the extracted sample was dried to constant weight. The difference between the weight before and after extraction was considered the amount of ether extract. The ether solution in the extraction flask was evaporated on a water bath to almost dryness and then dried to constant weight in an oven at 100°C. The weight of the oil was obtained and the percentage of ether extract calculated. The results are given in table 1.

Efficiency of the improvised ether-extract apparatus

For this study ground soybean was used as the sample. The soybean was placed in fat-free extraction thimble, weighed by difference, and then dried to constant weight. The thimble containing the moisture-free sample in the Erlenmeyer flask was tied with a small piece of copper wire and suspended from the cork stopper of the Erlenmeyer flask, as shown in figure 1 *a* and *b*. The cork stopper was covered with tin foil. At the beginning of the extraction, the thimble was lowered to the bottom of the Erlenmeyer flask so that the solvent came into intimate contact with the sample. Two hours before the thimble was to be removed from the flask it was raised above the level of the solvent. Then extraction was continued for the length of time required. The ether extract was determined by the loss in weight of the sample in the thimble. A series of experiments were performed to determine the relation between the length of time and the extent of extraction. Nine-, eighteen-, and twenty-five hour periods of extraction were tried. For control, the modified Cavannaugh-Soxhlet extraction apparatus was used. The results of these experiments are reported in table 3.

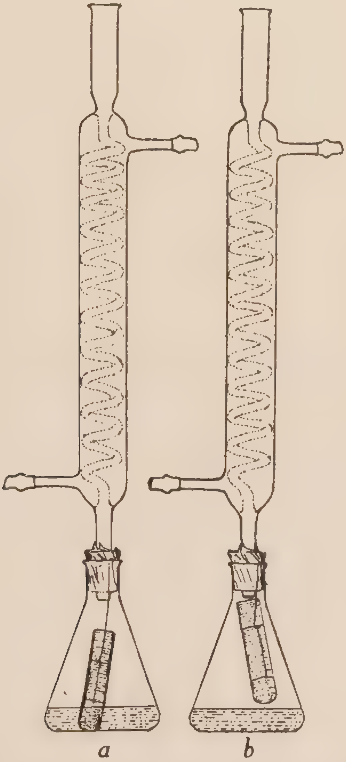

Fig. 1.—Diagram of Improvised Ether-Extraction Apparatus

a. Position of thimble in early stage of extraction

b. Position of thimble during later stage of extraction

DISCUSSION OF RESULTS

PART I

From table 1 it will be seen that the amount of ether extract obtained from the extraction flask was generally higher than the amount of ether extract obtained from the loss in weight of the sample in the thimble. One of the possible explanations which may be given for the higher results of the ether extract obtained from the extraction flask is the possibility of oxidation of the extract during drying. In order to verify this, the iodine numbers of the ether extract before and after drying were determined in the following way:

Determination of the iodine number of the extracted oil before and after drying (Hanus Method)

For this experiment ground soybean was placed in an extraction thimble and the ether extract obtained in the usual way. A sufficient amount of soybean oil was collected in this way and preserved in glass-stoppered weighing vessels.

About 0.2 gram of the oil was weighed into a 500 cc. glass-stoppered bottle. Then 10 cc. of chloroform were added to it, and when all had dissolved 50 cc. of Hanus iodine solution were included. It was then allowed to stand for half an hour with occasional shaking and after exactly 30 minutes 100 cc. of distilled water were added. The excess of iodine was titrated, with the standard sodium thiosulfate solution using starch as the indicator. A blank was run by using all the reagents of the above determination minus the oil. The volume of standard thiosulfate solution used by the sample subtracted from that obtained in the blank gave the amount of iodine absorbed by the sample. From these data, the iodine number of the oil was calculated. The iodine number of the ether extract, using the above method, was determined before drying. The extracted soybean oil was dried in exactly the same way as the ether extract obtained in the usual determination. This required from 3 to 4 hours. Then the iodine number of the dried oil was determined by the method described above. The results of the iodine number determination of the ether extract before and after drying are given in table 2. It will be seen, as expected, that the iodine number of the extract after drying was consistently lower than the iodine number of the extract before drying, which indicates that the extract during the drying has undergone oxidation. This oxidation in a way may account for the higher results of ether extract determination when the usual method was employed. The difference between the results obtained by using the two methods was not by any means a constant one. In many tests, the difference was relatively small, but in a few instances, the difference was comparatively great. In the former case, there was probably present in the extract a small amount of the unsaturated fatty acids, consequently less oxidation. Where the difference in results was great and in favor of the usual method, it was possible that there was a higher amount of the unsaturated fatty acids present in the extract and consequently greater oxidation. It seems apparent that the results of ether-extract determinations when reckoned from the loss in weight of the sample in the thimble are more reliable. Further experimentation is needed in order to finally establish the above statement. For the present at least, it becomes necessary whenever percentage of ether extract is reported also to indicate how it was obtained.

PART 2

Table 3 shows the extent of extraction using 9-, 18-, and 25-hour periods. It will be seen that about an 18-hour extraction period is quite sufficient. For lack of time and laboratory facilities no other range in the length of time of extraction period was tried.

From the table it has been found that the average extent of extraction using 9, 18, and 25 hours is 87.55 per cent, 94.87 per cent, and 96.74 per cent, respectively. These averages are calculated from the results of the control. Even with the 25-hour extraction period the extent of ether extraction compared with the control is only about 97 per cent. For the 18-hour period the extent of extraction was about 95 per cent. This indicates that there is very little recovery obtained by prolonging the period of extraction from 18 to 25 hours.

With the improvised apparatus the sample is immersed in the solvent only during the early stage of the extraction, but toward the later stage of the extraction, when the thimble containing the sample is raised above the level of the ether, this solvent no longer has a good chance to come into intimate contact with the sample and thus wash down completely the last traces of the fats or oil of the sample. On the other hand, when using the modified Soxhlet's extraction apparatus, the solvent ether has the chance from the start to the finish of the extraction to come into intimate contact with the sample, thus affecting a more complete extraction.

It is, however, recommended that by using a large variety of materials, further work be done on the extent of ether extraction secured by the improvised apparatus. Results of this work will disclose if there is a constant rate of extraction comparable to the results from employing the usual form of apparatus. In the event that the maximum extraction obtained by using the improvised apparatus bears a certain and constant relation to extraction obtained by the usual Soxhlet's apparatus, then by use of proper factors the results obtained by the former method may be converted into results as if the usual Soxhlet's apparatus had been used.

CONCLUSIONS

1. The ether extract when obtained from the weight of the extract recovered in the extraction flask was higher than that obtained from the loss in weight of the sample in the thimble.

2. The ether extract recovered in the extraction flask undergoes oxidation during the drying process.

3. As there was a significant difference in the amount of ether extract obtained by using two different methods of calculation on the same sample of material, it is necessary to indicate when reporting results the exact method used in obtaining the amount of ether extract.

4. An extraction apparatus which is cheap, easily constructed and gives promise of future usefulness, has been improvised.

LITERATURE CITED

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TABLE 1

Comparison between amount of ether extract obtained from the thimble and from the extraction flask

SAMPLE	PERCENTAGE OF ETHER EXTRACT:					
	FROM THIMBLE			FROM EXTRACTION FLASK		
	a	b	Average	a	b	Average
(Coconut meat)						
Coconut (desiccated), *Cocos nucifera* L.	55.31	55.50	55.40	54.09	54.77	55.43
Coconut (pressed), *Cocos nucifera*	28.34	28.31	28.32	27.86	28.32	28.12
(Cereal)						
Corn, fresh (fruit); *Zea mays* L.	0.86	0.71	0.79	0.98	0.90	0.94
(Dried fish)						
Tinapa, Young sardine (Clupeidae)	1.57	1.59	1.58	2.98	2.08	2.53
Tuyo, *Dussumeiria* sp. (Clupeidae)	5.82	5.85	5.84	6.04	6.54	6.29
(Fruits)						
Patani, *Phaseolus lunatus* L.	0.97	0.99	0.98	0.91	0.87	0.89
Santol, *Sandoricum koetjape* (Burm. f) Merr.	1.22	1.64	1.43	1.68	1.46	1.57
Sitao, *Vigna sesquipedalis* L. var.	0.84	0.59	0.72	0.99	0.76	0.88
(Grass)						
Guinea grass, *Panicum laxum*	0.71	1.22	0.97	0.85	1.19	1.02
Merker grass, *Pennisetum merkerrii* (4 weeks old)	1.09	0.77	0.83	0.93	0.88	0.91
Merker grass, *Pennisetum merkerrii* (6 weeks old)	0.62	0.75	0.69	0.53	0.45	0.49
(Leaves)						
Sweet potato, *Ipomoea batatas* L.	1.69	1.79	1.74	2.92	3.01	2.97
Tamarind shoots, *Tamarindus indica* L.	0.91	0.69	0.80	0.91	0.94	0.93
(Root)						
Gabi, *Colocasia esculentum* (L.) Schott	0.61	0.87	0.74	0.96	0.92	0.94
(Miscellaneous)						
Bicho-bicho	7.81	7.60	7.71	8.40	8.16	8.28
Sweetened chocolate	21.94	22.38	22.16	22.20	23.38	22.79

TABLE 2

Iodine number of soybean oil (ether extract)

SAMPLE NO.	BEFORE DRYING	AFTER DRYING AT 100°C.
1	117.91	100.36
2	116.66	103.63
3	———	100.56
4	———	100.07
5	———	100.98

TABLE 3

Effect of length of extraction period on the extent of extraction and a test of extraction efficiency of an improvised and cheap ether extraction apparatus

SAMPLE NO.	9 HOURS			18 HOURS			25 HOURS			CONTROL		
	Weight of sample	Wt. of ether extract	Ether extract	Weight of sample	Wt. of ether extract	Ether extract	Weight of sample	Wt. of ether extract	Ether extract	Weight of sample	Wt. of ether extract	Ether extract
	gram	*gram*	*per cent*	*gram*	*gram*	*per cent*	*gram*	*gram*	*per cent*	*gram*	*gram*	*per cent*
1	1.1923	0.2237	18.76	1.1158	0.2326	20.88	1.1981	0.2544	21.23	1.6226	0.3435	21.17
2	1.1284	0.2109	18.69	0.6303	0.1270	20.10	1.2737	0.2726	21.40	1.7155	0.5728	21.73
3	0.7881	0.1337	18.62	1.3723	0.2643	20.00	1.8715	0.3827	20.45	—	—	—
4	0.5668	0.1142	19.46	0.5306	0.1064	20.07	1.6347	0.3353	20.51	—	—	—
5	1.1460	0.2113	18.44	0.6763	0.1304	20.70	2.0789	0.4186	20.14	—	—	—
Average			18.78			20.35			20.75			21.45

STUDIES ON THE EFFECTS ON THE GROWTH OF CHICKS OF NIGHT FEEDING WITH THE AID OF ARTIFICIAL ILLUMINATION[1]

ANANIAS M. ZARATAN

INTRODUCTION

The brooding of young chicks is one of the major problems of a poultryman. In order that this work on a poultry farm may be conveniently distributed, it is sometimes necessary to extend the hatching of eggs over a number of months. Hence, late hatching may be a necessary operation on a poultry farm. It is in rearing the late hatched chicks that the poultry farmer finds real work, for these chicks should catch up with those that were hatched earlier in the season in order that the flock may be fairly uniform in size.

In his general lecture on the great benefits derived from the use of artificial lighting devices, Rice (1919) stated that by the use of artificial illumination surprising results were accomplished, not only in increased egg production but also in the production of remarkable growth in the case of growing pullets. Elford (1918), Aubry (1919) and Kaupp (1919) concluded that artificial light will bring the late coming pullets along so well that but few of these will need to be culled out as late starters. The artificial light seems to be a help in every way, but especially to those birds that are slow growers. Thus, with the aid of light by giving longer feeding hours, late hatched pullets were able to catch up with the earlier hatched birds.

All of the work on the use of artificial illumination so far reported refers principally to the advantages of using artificial illumination as an aid in forcing the pullets that are rather slow growers. In the Philippines, however, it has been the practice among duck raisers, at least along the shores of Laguna de Bay, from very early times, to give three or four extra feeding times to ducklings in the night, using an ordinary kerosene lantern to supply just enough light to enable the young animals to see their feed. These duck raisers claim that the actual normal length of time to maturity can be reduced to about four and one-half months (Fronda, 1929).

The object of the present experiment was to determine the value of artificial illumination as an aid in securing more rapid growth in brooding chicks. The experiment was conducted in the Department of Animal Husbandry, College of Agriculture, Los Baños, Laguna. It was started in March, 1927, and closed in July, 1928.

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[1] Thesis presented for graduation, 1929, with the degree of Bachelor of Science in Agriculture from the College of Agriculture No. 298; Experiment Station contribution No. 618. Prepared in the Department of Animal Husbandry under the direction of Dr. F. M. Fronda.

MATERIALS AND METHODS

Materials

Cantonese chicks were used in this experiment. Incubator, petroleum boxes as brooders, and petroleum lanterns were used in raising the chicks. The chicks were fed with the normal ration for growing chicks used by the Department. This ration is composed of equal parts of grain made of palay and cracked corn, and mash composed of corn meal, rice bran, copra meal, dried shrimps, and salt. Eggs were used to wet the corn meal and mash during the first three weeks of the brooding period.

Methods

Five hatches were made. The first hatch of 102 chicks was brought down on March 19; the second of 76 chicks on April 26; the third of 118 chicks on June 26; the fourth of 74 chicks on October 23, 1927, and the fifth hatch of 46 chicks was brought down on April 8, 1928. These hatches were each equally divided into lots I and II. Lot I was given normal feeding and lot II was given additional night feeding under artificial illumination at nine o'clock in the evening.

Brooding and housing. The chicks were brooded in a fireless brooder. Petroleum boxes were used for this purpose. Excelsior was used as bedding; this was changed every three days. Care was taken to prevent the chicks from overcrowding, by placing the proper number in each box.

Feeding and management. Twenty-four to forty-eight hours after hatching, the chicks were given their first feed of corn meal to which enough raw egg was added to moisten the feed. One egg mixed with the feed intended for every 30 chicks was considered sufficient. The chicks received this ration for a period of one week. The chicks in lot I were fed five times a day; those in lot II, six times. In addition to the five normal feedings during the day the chicks in lot II were fed at 9:00 o'clock in the evening with the aid of a kerosene lantern.

A Dietz kerosene lantern was used to supply the illumination needed to enable the chicks in lot II to see their feed. The light was placed on the floor at the center of the pen. The grain mixture was scattered on the floor around the lantern thus letting the chicks encircle the light as they ate. By tapping the floor with the fingers the chicks' attention could be attracted. It was noticed that they invariably looked down and picked up the grain. This was done until the chicks learned to eat their night meals. It took about fifteen minutes to feed the chicks at night.

Growth record. Twenty-four to forty-eight hours after hatching the chicks were leg-banded and weighed individually in a Henry Troemner arm balance to determine their initial weights. Then they were divided into two lots; namely, lots I and II. Subsequent weighings were made at intervals of one week throughout the duration of the experiment. In all cases the chicks were weighed before they were given their morning meal.

RESULTS

Tables 1, 2, 3, 4, and 5 show the average weekly weights of the chicks in the two lots. Table 6 gives the summary of the five sets of trials of the average weekly weights of the chicks with their corresponding probable errors. The differences between the averages of these weekly weights for lots I and II and the probable errors of these differences are also given. The ratio deviation or difference divided by its P. E. is given in a separate column. We are told by biometricians that when this ratio reaches a magnitude of three or greater, we can interpret with reasonable certainty that the difference arose not as a result of random sampling (as a result solely of chance) but has a significant meaning. The interpretation of such results appears under the column headed "remarks."

DISCUSSION OF RESULTS

The effect of night feeding

By reference to tables 1 to 5 inclusive, and the summary table 6, it would appear that artificial illumination exerted an appreciably beneficial effect on the growth of chicks. In all trials (see tables 1, 2, 3, 4, 5, and 6) the chicks that were subjected to artificial illumination seemed to show higher average weekly gains than those kept under normal method of feeding (lot I). A statistical treatment of the data, however, discloses that this is not exactly the case. In the treatment of these data the averages of all the chicks in lots I and II included in trials 1, 2, 3, 4, and 5 were taken, and their differences determined including the probable errors of the differences[2]. The formula used in computing the probable errors was Bessel's (Mendiola, 1924). The results of such work are summarized in table 6. It will be seen on studying the data presented in this table that lot II does not show significant differences in gain over lot I during the first seven weeks of the trial, but the difference in weight between these lots became very markedly significant from the eighth week and continued to be significant for five weeks thereafter until the experiments were completed.

It was observed also that the chicks in lot II grew feathers one week earlier than those in lot I. It would seem from this fact that during the early period of the experiment the chicks in lot II were probably utilizing a considerable part of their food in the early feather production. If such were the case, it would mean that the energy expended by the animals in the production of feathers can not be measured by its increase in weight.

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[2] The formula used in the determination of the probable errors was as follows: *P. E.* (probable error of the mean of several items) $\pm 0.6745 \sqrt{\frac{\Sigma d^2}{n(n-1)}}$ in which d refers to the deviation of the different items from their mean; n the number of items and Σ shows that the values d^2 are to be added. In determining the probable error of the difference, the formula used was $\pm \sqrt{A^2+B^2}$ in which A represents the probable error of one mean and B that of the other.

A second reason may be pointed out; namely, that the chicks may be utilizing a considerable portion of their energy in keeping themselves warm while feeding during the night, when it was invariably chilly. The operation of these two factors working together is very likely the most probable cause of this lack of significant gain of lot II over lot I during the earlier period of the experiment.

Do brooding chicks react to the effect of artificial feeding at a much later period than the laying hens? In this connection Kaupp (1924) found that the production of eggs could be increased fifty per cent as early as seven to ten days after the hens have been subjected to artificial illumination and feeding. In this experiment it took the artificially fed chicks fully seven weeks (49 days) to show significant advantage in weight over the normally fed chicks.

That the greater differences in favor of lot II over lot I were due very largely to the extra feed given them at night and not to the direct effect of artificial light are evidenced by the fact that the chicks in lot II actually consumed more grain feed than those in lot I. They also had more exercise which may have resulted in promoting general health, stronger constitution, and greater growth. If such is the case, it would serve to confirm the finding of Jordan (1915) who stated that hens given night feeding had more exercise, more feed, more water, followed by these results: stronger constitution, greater growth, and, lastly, the logical end of it all—greater egg production. In the present experiment, the beneficial effects of artificial lighting, and hence extra night feeding, was manifested in the more rapid growth of the chicks.

It may also be seen in the tables (1 to 5 inclusive) that the chicks in the different trials differed in weight. The differences in the weather conditions during the periods when the hatches were made may have been partly responsible for this. The important thing that must be pointed out in this connection, however, is that similar relationship regarding the average weight of the chicks in lots I and II existed throughout the brooding period, namely, whatever the initial weights were of the birds in different trials, the birds in lot II consistently made faster gains in all the trials than the birds in lot I, although these gains did not become statistically significant until after seven weeks of the brooding period.

Mortality

It is evident from the data obtained that the percentage of brooding mortality in all trials was greater in lot I than in lot II. The lower percentage of mortality among brooding chicks in lot II may have been due to the extra feed they received in the night feeding. They were given greater opportunity to eat and exercise which resulted in general health, greater strength, and vigorous constitution. This is in agreement with the statement of Kaupp (1924) in case of layers that lighted birds are not as susceptible to disease as are the unlighted individuals. Kamble *et al* (1928) stated also that fowls in good condition will stand lighting best and show the lowest percentage of mortality. It was observed also, that the different trials varied very greatly in their mortality during the brooding period, which in general was much beyond the normal expectations. The relationship between the two lots, however, is the same; namely, that lot I consistently showed much higher mortality than lot II. The weather condition that prevailed during the time the experiments were being carried out greatly influenced the percentage of mortality among the chicks in both lots.

Feed consumption

It was observed that the consumption of mash by week, per hundred chicks from the first to the twelfth week in lots I and II was exactly even. This was to be expected because the chicks were given the same amount of mash. During the early part of the experiment the chicks in lot II were given mash, but it was noticed that they did not take any of it; consequently it was discontinued. Undoubtedly, the chicks ate grain because the lantern gave just enough light to let them see it. The weekly consumption of grain per hundred chicks was higher in lot II than in lot I for this reason. This higher weekly consumption of grain over those under normal conditions undoubtedly helped to produce the large individuals in that lot. The amount of feed consumed by the normal lot was about equal to that observed by Paje (1927). This may be expected in view of the fact that Paje's work was followed very closely, and used as a guide in feeding the chicks.

SUMMARY OF CONCLUSIONS

1. By means of artificial illumination chicks may be forced to take more feed.
2. The difference in weight from those on normal feed that the lighted chicks showed as a result of forced feeding is not appreciably significant during the first seven weeks of the brooding period.
3. No appreciable influence of extra feeding was shown until after the chicks attained the age of seven weeks. This difference became markedly significant after that period and continued to be significant for at least five weeks thereafter, or until the experiments were concluded.
4. The beneficial influence of the artificial lighting used in this experiment was manifested in the rapid growth of the chicks.
5. The percentage of mortality during the brooding period in all lots was unusually high, but it is significantly higher in the normal lots than in the lots that were given artificial light. The highest percentage of mortality in both lots occurred during the first four weeks.
6. During the night feeding which was forced through the aid of artificial illumination the chicks consumed grain very largely.

7. The chicks under artificial illumination developed feathers earlier than those under the normal lot.

8. It was observed also that the chicks given artificial illumination were apparently more vigorous than those in the check lot.

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TABLE 1

Average weekly weights of Cantonese chicks in the normal and artificial illumination lots. (First trial. Hatched March 19, 1927.)

AGE	LOT I (NORMAL)		LOT II (ARTIFICIAL ILLUMINATION)		DIFFERENCE IN FAVOR OF LOT II
	Number of chicks	Average weight	Number of chicks	Average weight	
weeks		*grams*		*grams*	*grams*
Initial	51	24.5	51	25.8	1.3
1	42	26.2	40	28.1	1.9
2	30	32.3	39	35.2	2.9
3	20	41.1	24	46.7	5.6
4	15	64.3	21	70.5	6.2
5	15	92.5	21	100.4	7.9
6	13	138.5	21	131.7	-6.8
7	13	170.3	20	177.6	7.3
8	13	226.1	20	238.0	11.9
9	13	290 6	20	307.3	16.7
10	13	350.5	20	379.9	29.4
11	13	408.0	20	462.3	54.3
12	13	449.1	20	507.8	58.7

TABLE 2

Average weekly weights of Cantonese chicks in the normal and artificial illumination lots. (Second trial. Hatched April 26, 1927.)

AGE	LOT I (NORMAL)		LOT II (ARTIFICIAL ILLUMINATION)		DIFFERENCE IN FAVOR OF LOT II
	Number of chicks	Average weight	Number of chicks	Average weight	
weeks		*grams*		*grams*	*grams*
Initial	38	24.7	38	24.7	——
1	35	25.5	37	27.7	2.2
2	32	29.1	36	35.4	6.3
3	30	42.6	36	49.5	6.9
4	29	68.5	35	78.6	10.1
5	29	101.2	35	15.8	14.6
6	29	152.4	35	172.5	20.1
7	29	171.8	35	196.1	24.3
8	29	193.8	35	239.3	35.5
9	29	220.1	35	281.6	61.5
10	29	254.3	35	316.5	62.2
11	28	283.1	35	352.4	69.3
12	28	309.4	35	395.6	86.2

TABLE 3

Average weekly weights of Cantonese chicks in the normal and artificial illumination lots. (Third trial. Hatched June 26, 1927.)

AGE	LOT I (NORMAL)		LOT II (ARTIFICIAL ILLUMINATION)		DIFFERENCE IN FAVOR OF LOT II
	Number of chicks	Average weight	Number of chicks	Average weight	
weeks		*grams*		*grams*	*grams*
Initial	59	26.6	59	25.9	-0.7
1	49	29.4	59	28.8	-0.6
2	41	33.1	50	32.4	-0.7
3	34	36.1	38	39.7	3.6
4	18	47.4	33	50.5	3.1
5	14	63.1	27	73.2	10.1
6	14	77.8	25	60.4	-17.4
7	13	105.4	24	136.2	30.8
8	12	136.2	23	168.8	32.6
9	11	177.8	20	214.4	36.6
10	11	206.8	16	292.5	85.7
11	11	243.2	16	342.2	99.0
12	11	260.5	16	389.1	128.6

TABLE 4

Average weekly weights of Cantonese chicks in the normal and artificial illumination lots. (Fourth trial. Hatched October 23, 1927.)

AGE	LOT I (NORMAL)		LOT II (ARTIFICIAL ILLUMINATION)		DIFFERENCE IN FAVOR OF LOT II
	Number of chicks	Average weight	Number of chicks	Average weight	
weeks		*grams*		*grams*	*grams*
Initial	37	22.2	37	22.9	0.7
1	37	25.4	37	26.4	1.0
2	34	31.0	35	34.6	3.6
3	27	42.2	30	50.5	8.3
4	21	65.1	27	75.7	10.6
5	19	88.7	24	114.4	25.7
6	15	123.1	19	159.4	36.3
7	14	159.2	17	209.0	49.8
8	14	182.6	17	257.7	75.1
9	13	234.8	17	309.2	74.4
10	13	281.6	17	366.5	84.9
11	12	326.3	17	423.8	97.5
12	12	386.5	17	493.4	106.9

TABLE 5

Average weekly weights of Cantonese chicks in the normal and artificial illumination lots. (Fifth trial. Hatched April 8, 1928.)

AGE	LOT I (NORMAL)		LOT II (ARTIFICIAL ILLUMINATION)		DIFFERENCE IN FAVOR OF LOT II
	Number of chicks	Average weight	Number of chicks	Average weight	
weeks		*grams*		*grams*	*grams*
Initial	23	24.1	23	24.0	-0.1
1	23	26.4	23	26.2	-0.2
2	23	32.0	21	35.6	3.6
3	21	40.9	20	49.2	8.3
4	15	60.3	18	71.0	10.7
5	15	92.8	16	113.4	20.6
6	14	114.3	15	148.2	43.9
7	14	137.2	15	183.1	45.9
8	12	179.7	14	227.1	47.4
9	12	211.2	14	265.8	54.6
10	12	249.9	14	310.4	60.5
11	12	308.1	14	380.8	72.7
12	12	369.8	14	465.8	96.0

TABLE 6

Summary of the five trials of the average weight of Cantonese chicks in the normal and artificial illumination lots

AGE	LOT I (NORMAL)			LOT II (ARTIFICIAL ILLUMINATION)			DIFFERENCE BETWEEN EXPERIMENTAL AND CHECK LOTS		DEVIATION P. E.	REMARKS
	Number of chicks	Average weights	P. E.	Number of chicks	Average weights	P. E.	Deviation	P. E.		
weeks		*grams*			*grams*					
Initial	208	24.4	± 0.472	208	24.7	± 0.381	+ 0.3	± 0.606	0.495	Not significant
1	186	26.6	± 0.491	196	27.4	± 0.337	+ 0.8	± 0.595	1.340	" "
2	160	31.5	± 0.462	181	36.6	± 0.685	+ 5.1	± 1.852	2.750	" "
3	152	40.6	± 2.287	148	47.1	± 1.319	+ 6.5	± 2.604	2.490	" "
4	98	61.1	± 2.475	134	69.3	± 3.321	+ 8.2	± 4.141	1.980	" "
5	92	87.7	± 4.364	123	101.4	± 5.452	+13.7	± 6.984	0.530	" "
6	85	121.2	± 8.307	115	134.4	±13.267	+13.2	±15.267	0.840	" "
7	83	148.8	± 8.421	111	180.4	± 8.306	+31.6	±11.828	2.670	" "
8	81	183.7	± 6.743	109	226.2	±10.227	+42.5	±14.125	3.000	Significant
9	78	226.9	±12.458	106	275.7	± 6.081	+48.8	±13.804	3.540	"
10	78	268.6	±15.997	102	333.2	± 8.041	+64.6	±17.904	3.610	"
11	76	313.7	±16.465	102	392.3	±15.908	+78.6	±24.371	3.230	"
12	76	355.1	±21.895	102	450.3	±17.153	+95.2	±27.813	3.420	"

PROPAGATION OF CITRUS PLANTS BY STEM CUTTINGS[1]

EDUARDO A. MENDOZA

WITH ONE TEXT FIGURE

Citrus plants may be propagated by seed or by some vegetative parts. The propagation by seed is easy, but the resulting plants are variable. Many plants grown from seeds of sweet Chinese pummelo of superior quality bear fruit of mediocre quality, often sour and bitter, making them useless for commercial purposes.

The asexual method of propagating Citrus is more difficult to perform, but the resulting plant is usually true to type. Of the vegetative methods, budding is universally followed in the United States where the best Citrus orchards in the world are to be found. In the Philippine Islands, however, the immediate need of the people is a method easy to perform and one that will not require previous technical training.

Object of the present work

The object of the present work was to determine the feasibility of growing Citrus plants from stem cuttings under local conditions.

Review of the literature on the subject

Not much work on the propagation of Citrus plants by stem cuttings has been done. Webber (1896) states that lemons, citrons, and limes are sometimes propagated by cuttings; also that oranges and pummelos may be propagated in this way, but admits that this method is seldom followed, for the cuttings do not root readily. In describing the method Webber says that the cuttings should be taken from young wood and the twigs cut into scions from four to six inches in length, leaving one or two leaves attached to the upper end. With a sharp knife the base should be cut with a smooth slanting cut. The cuttings may be planted in convenient boxes filled with sand. The rooting of the cuttings can be facilitated with the use of bottom heat. The cuttings may be transplanted. When they sprout and attain a height of eight inches, they are ready for transplanting.

Rolfs (1913) states that lemons, limes, pummelos, and other species may be propagated from cuttings, which should be made from fairly mature wood so as to give considerable moisture and warmth to the soil.

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Wester (1913) states that Citrus may be propagated from cuttings, seeds, inarching, marcotting, budding, and grafting. Of these methods, he claims budding is the best.

Curtis (1918) made some investigations to determine the effect of various chemical compounds on the rest period of woody plants. He found that when twigs of *Ligustrum vulgare* L. were treated with potassium permanganate, the roots formed more readily than the untreated checks or the twigs treated with other compounds. He suggested that potassium permanganate stimulated the production of roots by making the food stored in the stem available for immediate use.

Swingle, Robinson, and May, Jr., (1924), found that Citrus plants can be propagated by cuttings by the use of the solar propagating frame. They found that many plants which are not readily propagated by cuttings may be propagated in this way if the cuttings are properly selected and the right treatment is given. They likewise found that in a greenhouse where the temperature can be controlled, good results can be obtained with most Citrus varieties by maintaining a soil temperature of 80° to 90°F. with the air temperature somewhat cooler (70° to 80°F.).

Polo (1925) tried to propagate lanzones by growing marcots and cuttings. He obtained good results by marcotting; but the cuttings, both untreated and treated with potassium permanganate, did not grow.

Hume (1926) claims that Citrus may be propagated asexually by budding, grafting, cutting or layering. In greenhouse practice some ornamental sorts are propagated from cuttings, but in the United States this method is seldom employed for multiplying commercial Citrus varieties. He found that budding is by far the most important method used in all Citrus districts. He says that many varieties of Citrus trees may be propagated from cuttings, and it is possible that this method may have value in the future as a means of propagating stocks of uniform character. The citrons and the lemon produce roots readily. Cuttings of pummelo and orange are very difficult to root and, though it may be accomplished, the method has little value and is not practicable.

Albino (1928) worked on the propagation of Para rubber by cuttings and obtained a negative result. He found that the cuttings did not even callus but produced vigorous shoots. The effects of bottom heat on root production were not tried.

Louire (1928) found that certain chemicals can be used in rooting cuttings. A two per cent sugar solution proved beneficial in the case of carnation, lilac, climbing Euonymus and heliotrope. A 0.1 per cent $KMnO_4$ aided lilac, Euonymus, barberry, heliotrope, Coleus, Chrysanthemum, and carnation cuttings. Vinegar, three teaspoonfuls to a gallon of water, stimulated the growth of lilac, Chrysanthemum, and Euonymus. These solutions hastened the production of roots instead of increasing the percentage of rooted cuttings.

Time and place of the present work

This work was carried out in the College of Agriculture Nursery, Los Baños, Laguna, between April, 1928, and February, 1929.

MATERIALS AND METHODS

In this experiment, Batangas mandarin (*Citrus nobilis* Lour.), calamondin (*C. mitis* Blanco), kusaie lime (*C. aurantifolia* Swingle), and pummelo (*C. maxima* Merrill) were used. Cuttings of these four species were prepared from branches of different ages, young, medium, and old. They were cut from nine to ten centimeters long.

Sterilized sand was used as the growing medium. The sand was sterilized by putting it on an iron sheet and heating it for about four hours, stirring it from time to time. The sterilized sand was passed through a sieve to eliminate the coarse particles. It was then put into longitudinal halves of petroleum cans. To provide drainage, holes were punched in the bottom of these cans. To increase drainage the coarser sand was put in the bottom of the cans and the finer on top. The depth of the layer of fine sand was about ten centimeters. These cans were put in petroleum boxes, two cans to a box.

Before planting the cuttings, they were soaked in a disinfectant. In the early part of this experiment 10 per cent boric acid was used, but it was found ineffective as the cuttings were attacked by fungus. This solution was replaced by 3 per cent "Dipdust".[2] When 10 per cent boric acid was used the cuttings were soaked from three to five minutes, but with the 3 per cent "Dipdust" solution they were soaked for two minutes.

EXPERIMENTS AND RESULTS

Two sets of experiments were conducted. The first set was started April 13, 1928. Ninety cuttings from each of the four species of Citrus named were prepared. Ten cuttings from each age were cut between the nodes, and 20 just at the base of the nodes, 10 branches were with leaves and 10 without. The prepared cuttings were soaked in 10 per cent boric acid solution for disinfection, but it proved ineffective, so a 3 per cent Dipdust[2] solution was used instead. The cuttings were planted in the petroleum cans, one variety to a can. They were planted in straight rows, one age to a row, ten cuttings to a row placed about two centimeters apart.

Influence of bottom heat

Bottom heat was used in this experiment. A hole one and a half meters long, one-half meter wide and thirty centimeters deep was dug in the

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[2] Dipdust is an organic mercuric compound. The composition, as given by the manufacturers, is as follows:

Hydroxymercurichlorophenol sulfate	6%
Hydroxymercurinitrophenol sulfate	2%
Inert ingredient	92%

ground. Six halves of petroleum cans cut longitudinally were placed side by side over the hole, crosswise and cemented with soft clay to close all openings, except the door of what may be termed the oven for convenience. This opening was fitted with a tight but removable wooden door. To supply the heat, three half petroleum cans (cut longitudinally) of fresh horse manure were placed in the bottom of the hole. In another set of experiments fire was used instead of the manure. Coarse rice bran was burned at the bottom of the hole. This fuel was supplied constantly. The temperature of the air and soil, above and below the surface, was taken three times a day. Full results of the experiments, including detail as to species and number of cuttings used, are shown in table 1.

Influence of light intensity

To determine the influence of intensity of sunlight, two boxes with four varieties were placed inside the building; two boxes with three varieties were in direct sunshine; and two boxes with three varieties were in partial shade. The boxes in the building were used as control. The cuttings were prepared in the usual way, soaked in 10 per cent boric acid, and then planted. Holes were made in the sand in which the cuttings were carefully placed.

The following observations were taken during the course of the experiment.

All the cuttings placed in direct sunshine were dead at the end of four days. They were badly scorched. Observations made three times a day showed that the heat of the planting medium varied from 39° to 45°C. Undoubtedly, the cuttings were killed by the excessive heat. The results of the other experiments are given in tables 2 and 3.

Influence of intensity of air humidity

In this experiment the cans used as flats were placed in boxes, two cans in each box, which were then covered with glass after the plants were thoroughly watered to keep the humidity high. Two hundred ninety cuttings were used. The preparation and treatment of the cuttings were the same with the other lots. The results are summarized in table 4.

Influence of potassium permanganate solution

To find the influence of potassium permanganate treatment, the cuttings were treated with 1 to 5 per cent solution for one hour. In the process, the basal part of the cuttings to the length of two centimeters was soaked in the solution. Two sets of experiments were run one after the other, using a total of 2,700 cuttings. They were prepared as in the other lots. Batangas mandarin, calamondin and kusaie lime were used. Tables 5 and 6 give the results of the experiment.

Influence of callusing the cuttings before planting.

The effect of letting the cuttings callus before taking them from the tree was tried, using twigs of calamondin, *Citrus mitis*. Branches of three different ages were used. The process consisted of removing a ring of bark about one centimeter wide either below or between the nodes. In some cases, a few leaves were left. The time it took the branches to callus was recorded. The cuttings were planted as in the other lots. Table 7 shows the number of branches used and the result of the experiment.

DISCUSSION OF RESULTS

As shown in table 1, of all the four species of Citrus used in this experiment, *Citrus aurantifolia* was the only one that produced roots, except a single cutting of pummelo. As the treatment given to the cutting was similar and in the absence of any knowledge on which to base opinion as to these striking results, it may be suggested that this behavior might be due to varietal characteristics.

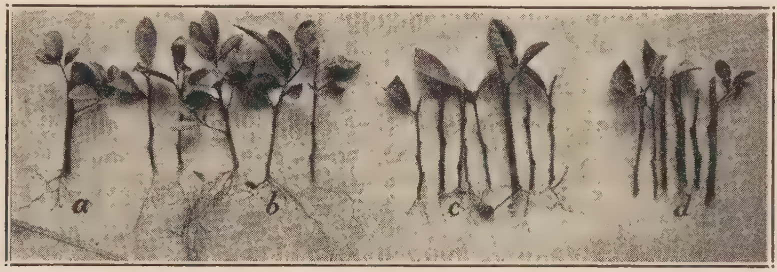

Fig. 1.—Citrus Stem Cuttings

a. Kusaie lime treated with potassium permanganate; rooted 20 days after callusing

b. Kusaie lime under partial shade; rooted 15 days after callusing

c. Kusaie lime and pummelo treated with bottom heat; rooted 7 days after callusing

d. Control; callused but did not root

Bottom heat proved to be the best of all the treatments used in this experiment. The influence of the treatment was so marked that the callus was formed in about 13 days, and rooting followed 7 days later. Records of the temperature of the sand in the two methods of applying bottom heat, namely, by manure and by directly burning coarse rice hulls under the seed flat, show that the manure had a range of 29° to 32°C., and burning rice hulls 35° to 40°C. Compared with the temperature of the air, there was an increase of 1° to 2°C. in the first and 7° to 10°C. in the second. The result is not significant, but it would seem that burning the rice hulls is the more desirable, if the increase in temperature, as is generally believed, is the main consideration. Furthermore, the use of fresh horse manure for producing bottom heat is rather inconvenient and takes about as much time as burning the rice hulls.

The bottom heat method is, of course, the standard way of inducing cuttings to root. Dr. L. G. Gonzalez has informed the writer that stem cuttings of different species of plants, including papaya, avocado, and figs have been successfully rooted by applying bottom heat at the greenhouses of the Bureau of Plant Industry in Washington, D. C. A report by Swingle, Robinson, and May, Jr. (1924), showed that bottom heat is conducive to root formation. In this work the heat was obtained from the sun.

Reasons for this influence of bottom heat to hasten rooting may be due to unequal activity of the upper and lower parts of the aerial and the submerged portion of the cuttings as directly influenced by the prevailing temperature. Respiratory and other physiological activities may be expected to be slightly more at the lower part of the cuttings, and it is easy to see how root formation may precede the formation of shoots or young branches. In this connection, it has been noted that whenever new growths appeared, no roots were formed and the cuttings died a few days later, probably after the stored food in the branch had been used up by the young shoots. It seems that the question is really one of food economics. It is assumed that before the roots are formed the cuttings are not able to synthesize food at all.

Medium age cuttings were found to give better results than either the old or the young ones. The cuttings which were cut below the node were found to callus and to root more readily than those cut between the nodes. The twigs which were cut between the nodes callused, but no sign of root formation was noted. The best results were obtained with twigs which were cut at the base of the node with two or three leaves left. This may be explained on the basis of the findings of Knight (1809) and confirmed by Swingle (1927) that potential roots of certain species are to be found at the base of the nodes while in certain species they are internodal. This is significant in preparing stem cuttings for planting.

The cuttings which were placed under direct sunshine died four days after planting. The tissues were discolored and showed signs of having been over-heated. Undoubtedly, the excessive temperature was fatal to the cuttings.

Those cuttings which were placed inside the building began to fail nine days after planting. Many of them produced shoots but were not able to form a callus before they died. Some of the cuttings (except those of Batangas mandarin) treated in this manner callused but did not root. Of the two trials, the best results were obtained from those kept under the trees. In the first trial 3.3 per cent rooted and in the second trial, 26.6 per cent. In both cases only kusaie lime formed roots. The percentage of success was rather low, but the consistency of the result may be taken as a suggestion of better conditions for the cuttings to root. These better conditions may be due to a lower temperature around the shaded portion and there was perhaps less evaporation from the tissue. While the sunshine was not intense in the Nursery Building, evaporation was probably faster than where the cuttings were screened by the green leaves of the shade plant.

When the glass covering was placed over the top of the box in which the cuttings were planted the percentage of humidity inside was greatly increased. Unfortunately, fungous infection set in badly and the cuttings were the first to show signs of death. After the top portion died, fungous attack followed and all of the cuttings under this treatment died within 20 days without any sign of callus formation.

Potassium permanganate solution in the different strengths used did not induce the callusing and rooting of the cuttings. All of the three species treated with this solution produced vigorous shoots, but they, and also the treated portion, soon died.

In the second trial, however, one old cutting from kusaie lime, which was cut at the base of the node with three leaves left on, callused on November 23, 1928, and rooted 22 days after. These rooted cuttings neither callused nor produced roots on the part which was soaked in the solution, but they did a little above, which is unlike the other rooted cuttings. A few suggestions may be considered. Either the plant is not responsive to the treatment, as in the findings of Polo (1925) with lanzon, and Albino (1928) with Para rubber, or the solution used was too strong for the branches. The single cutting with the roots formed at the point above the potassium permanganate treatment would tend to strengthen the latter conclusion. The response of the cuttings to the same treatment with a certain other combination, such as bottom heat, may prove a more satisfactory method.

SUMMARY OF CONCLUSIONS

1. Of the different treatments used to induce rooting in stem cuttings of Citrus, bottom heat proved the best. Two methods of obtaining bottom heat were tried in these experiments.
2. A 3 per cent Dipdust solution seems to be a better disinfectant for Citrus cuttings than a 10 per cent solution of boric acid.
3. Increased humidity of the air did not affect the cuttings favorably. In fact, it was conducive to fungous growth.
4. The 1 to 5 per cent solution of potassium permanganate used did not induce the cuttings to root. The part of the cuttings which was dipped in the solution decayed when planted, suggesting that the treatment was too strong.
5. Some cuttings placed in partial shade rooted and grew, although it took fifteen days for the plants to produce roots.

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TABLE 1

Effect of bottom heat on the root formation of citrus cuttings

Set 1

Horse manure was used as the source of heat

SPECIES OF CITRUS USED	NUMBER OF CUTTINGS PLANTED	AGE OF BRANCH USED	DATE PLANTED	DATE CALLUSED	DATE ROOTED	NUMBER OF CUTTINGS ROOTED	PERCENTAGE
			1928				
maxima Merrill....	30	Young	1-VIII	——	——	——	0
	30	Medium	1-VIII	——	——	——	0
	30	Old	1-VIII	——	——	——	0
aurantifolia Swingle.........	30	Young	1-VIII	——	——	——	0
	30	Medium	1-VIII	8–13–28	8–20–28	7	23
	30	Old	1-VIII	8–13–28	8–29–28	1	3.3
mitis Blanco......	30	Young	1-VIII	——	——	——	0
	30	Medium	1-VIII	——	——	——	0
	30	Old	1-VIII	——	——	——	0
nobilis Lour......	30	Young	5-VIII	——	——	——	0
	30	Medium	5-VIII	——	——	——	0
	30	Old	5-VIII	——	——	——	0

Set 2

Direct fire was used as the source of heat

			1928				
aurantifolia.......	30	Young	17-XI	——	——	——	0
	30	Medium	17-XI	11-30-28	12- 7-28	6	20
	30	Old	17-XI	11-30-28	12-10-28	6	20
maxima..........	30	Young	17-XI	——	——	——	0
	30	Medium	17-XI	12- 7-28	——	——	0
	30	Old	17-XI	12- 7-28	12-30-28	1	3.3
nobilis...........	30	Young	20-XI	——	——	——	0
	30	Medium	20-XI	——	——	——	0
	30	Old	20-XI	——	——	——	0
mitis.............	30	Young	20-XI	——	——	——	0
	30	Medium	20-XI	——	——	——	0
	30	Old	20-XI	——	——	——	0

TABLE 2

Influence of intensity of sunlight on citrus cuttings

Set 1

SPECIES OF CITRUS USED	INTENSITY OF SUNLIGHT	NUMBER OF CUTTINGS PLANTED	AGE OF BRANCH	DATE PLANTED	DATE CALLUSED	DATE ROOTED	NUMBER OF CUTTINGS ROOTED	PERCENTAGE
				1928	1928	1928		
nobilis	Inside building	30	Young	13-IV	——	——	——	0
	“ “	30	Medium	13-IV	——	——	——	0
	“ “	30	Old	13-IV	——	——	——	0
aurantifolia	“ “	30	Young	13-IV	23-IV	——	——	0
	“ “	30	Medium	13-IV	——	——	——	0
	“ “	30	Old	13-IV	——	——	——	0
mitis	“ “	30	Young	19-IV	——	——	——	0
	“ “	30	Medium	19-IV	15-V	——	——	0
	“ “	30	Old	19-IV	——	——	——	0
maxima	“ “	30	Young	19-IV	——	——	——	0
	“ “	30	Medium	19-IV	20-V	——	——	0
	“ “	30	Old	19-IV	——	——	——	0
aurantifolia	Direct sunshine	30	Young	16-IV	——	——	——	0
	“ “	30	Medium	16-IV	——	——	——	0
	“ “	30	Old	16-IV	——	——	——	0
nobilis	“ “	30	Young	19-IV	——	——	——	0
	“ “	30	Medium	19-IV	——	——	——	0
	“ “	30	Old	19-IV	——	——	——	0
mitis	“ “	30	Young	19-IV	——	——	——	0
	“ “	30	Medium	19-IV	——	——	——	0
	“ “	30	Old	19-IV	——	——	——	0
mitis	Under tree	30	Young	27-IV	15-V	——	——	0
	“ “	30	Medium	27-IV	8-V	——	——	0
	“ “	30	Old	27-IV	——	——	——	0
nobilis	“ “	30	Young	5-V	17-V	——	——	0
	“ “	30	Medium	5-V	17-V	——	——	0
	“ “	30	Old	5-V	——	——	——	0
aurantifolia	“ “	30	Young	8-V	15-V	——	——	0
	“ “	30	Medium	8-V	15-V	5-VI	1	3.3
	“ “	30	Old	8-V	15-V	——	——	0

TABLE 3

Effect of intensity of sunlight on citrus cuttings

Set 2

SPCIEES OF CITRUS USED	INTENSITY OF SUNLIGHT	NUMBER OF CUTTINGS PLANTED	AGE OF BRANCH	DATE PLANTED	DATE CALLUSED	DATE ROOTED	NUMBER OF CUTTINGS ROOTED	PERCENTAGE
				1928	1928	1929		
mitis	Inside building	30	Young	1-IX	——	——	——	0
	" "	30	Medium	1-IX	1-XI	——	——	0
	" "	30	Old	1-IX	1-XI	——	——	0
nobilis	" "	30	Young	1-IX	——	——	——	0
	" "	30	Medium	1-IX	——	——	——	0
	" "	30	Old	1-IX	——	——	——	0
aurantifolia	" "	30	Young	3-IX	——	——	——	0
	" "	30	Medium	3-IX	20-IX	——	——	0
	" "	30	Old	3-IX	20-IX	——	——	0
maxima	" "	30	Young	3-IX	——	——	——	0
	" "	30	Medium	3-IX	——	——	——	0
	" "	30	Old	3-IX	——	——	——	0
nobilis	Under tree	30	Young	19-IX	——	——	——	0
	" "	30	Medium	19-IX	——	——	——	0
	" "	30	Old	19-IX	——	——	——	0
aurantifolia	" "	30	Young	20-IX	——	——	——	0
	" "	30	Medium	20-IX	1-X	18-X	6	20
	" "	30	Old	20-IX	23-IX	10-XI	2	6.6
mitis	" "	30	Young	20-IX	——	——	——	0
	" "	30	Medium	20-IX	——	——	——	0
	" "	30	Old	20-IX	——	——	——	0

TABLE 4

Effect of intensity of air humidity on cuttings of Citrus

Set 1

SPECIES OF CITRUS USED	NUMBER OF CUTTINGS PLANTED	AGE OF BRANCH	DATE PLANTED	DATE CALLUSED	DATE ROOTED	NUMBER OF CUTTINGS ROOTED	PERCENTAGE
			1928				
nobilis	30	Young	18-IV	——	——	——	0
	30	Medium	18-IV	——	——	——	0
	30	Old	18-IV	——	——	——	0
aurantifolia	30	Young	18-IV	——	——	——	0
	30	Medium	18-IV	——	——	——	0
	30	Old	18-IV	——	——	——	0
mitis	30	Young	19-IV	——	——	——	0
	30	Medium	19-IV	——	——	——	0
	30	Old	19-IV	——	——	——	0
maxima	30	Young	19-IV	——	——	——	0
	30	Medium	19-IV	——	——	——	0
	30	Old	19-IV	——	——	——	0

Set 2

			1928				
mitis	30	Young	18-VIII	——	——	——	0
	30	Medium	18-VIII	——	——	——	0
	30	Old	18-VIII	——	——	——	0
maxima	30	Young	18-VIII	——	——	——	0
	30	Medium	18-VIII	——	——	——	0
	30	Old	18-VIII	——	——	——	0
nobilis	30	Young	26-VIII	——	——	——	0
	30	Medium	26-VIII	——	——	——	0
	30	Old	26-VIII	——	——	——	0
aurantifolia	30	Young	26-VIII	——	——	——	0
	30	Medium	26-VIII	——	——	——	0
	30	Old	26-VIII	——	——	——	0

TABLE 5

Effect of different concentrations of potassium permanganate solution on the root formation of Citrus cuttings

Set 1

SPECIES OF CITRUS USED	STRENGTH OF SOLUTION	LENGTH OF TREATMENT	NUMBER OF CUTTINGS PLANTED	AGE OF BRANCH	DATE PLANTED	DATE CALLUSED	DATE ROOTED	NUMBER OF CUTTINGS ROOTED	PERCENTAGE
	per cent	*hour*			1928				
mitis	1	1	30	Young	11-V	—	—	—	0
	1	1	30	Medium	11-V	—	—	—	0
	1	1	30	Old	11-V	—	—	—	0
	2	1	30	Young	12-V	—	—	—	0
	2	1	30	Medium	12-V	—	—	—	0
	2	1	30	Old	12-V	—	—	—	0
	3	1	30	Young	12-V	—	—	—	0
	3	1	30	Medium	12-V	—	—	—	0
	3	1	30	Old	12-V	—	—	—	0
	4	1	30	Young	16-V	—	—	—	0
	4	1	30	Medium	16-V	—	—	—	0
	4	1	30	Old	16-V	—	—	—	0
	5	1	30	Young	16-V	—	—	—	0
	5	1	30	Medium	16-V	—	—	—	0
	5	1	30	Old	16-V	—	—	—	0
aurantifolia	1	1	30	Young	23-V	—	—	—	0
	1	1	30	Medium	23-V	—	—	—	0
	1	1	30	Old	23-V	—	—	—	0
	2	1	30	Young	23-V	—	—	—	0
	2	1	30	Medium	23-V	—	—	—	0
	2	1	30	Old	23-V	—	—	—	0
	3	1	30	Young	31-V	—	—	—	0
	3	1	30	Medium	31-V	—	—	—	0
	3	1	30	Old	31-V	—	—	—	0
	4	1	30	Young	31-V	—	—	—	0
	4	1	30	Medium	31-V	—	—	—	0
	4	1	30	Old	31-V	—	—	—	0
	5	1	30	Young	23-VI	—	—	—	0
	5	1	30	Medium	23-VI	—	—	—	0
	5	1	30	Old	23-VI	—	—	—	0
nobilis	1	1	30	Young	24-VI	—	—	—	0
	1	1	30	Medium	24-VI	—	—	—	0
	1	1	30	Old	24-VI	—	—	—	0
	2	1	30	Young	26-VI	—	—	—	0
	2	1	30	Medium	26-VI	—	—	—	0
	2	1	30	Old	26-VI	—	—	—	0
	3	1	30	Young	26-VI	—	—	—	0
	3	1	30	Medium	26-VI	—	—	—	0
	3	1	30	Old	26-VI	—	—	—	0
	4	1	30	Young	28-VI	—	—	—	0
	4	1	30	Medium	28-VI	—	—	—	0
	4	1	30	Old	28-VI	—	—	—	0
	5	1	30	Young	28-VI	—	—	—	0
	5	1	30	Medium	28-VI	—	—	—	0
	5	1	30	Old	28-VI	—	—	—	0

TABLE 6

Effect of different concentrations of potassium permanganate solution on the root formation of Citrus cuttings

Set 2

SPECIES OF CITRUS USED	STRENGTH OF SOLUTION	LENGTH OF TREATMENT	NUMBER OF CUTTINGS PLANTED	AGE OF BRANCH	DATE PLANTED	DATE CALLUSED	DATE ROOTED	NUMBER OF CUTTINGS ROOTED	PERCENTAGE
	per cent	*hour*			1928	1928	1928		
mitis	1	1	30	Young	27-X	——	——	——	0
	1	1	30	Medium	27-X	——	——	——	0
	1	1	30	Old	27-X	——	——	——	0
	2	1	30	Young	27-X	——	——	——	0
	2	1	30	Medium	27-X	——	——	——	0
	2	1	30	Old	27-X	——	——	——	0
	3	1	30	Young	25-X	——	——	——	0
	3	1	30	Medium	25-X	——	——	——	0
	3	1	30	Old	25-X	——	——	——	0
	4	1	30	Young	25-X	——	——	——	0
	4	1	30	Medium	25-X	——	——	——	0
	4	1	30	Old	25-X	——	——	——	0
	5	1	30	Young	25-X	——	——	——	0
	5	1	30	Medium	25-X	——	——	——	0
	5	1	30	Old	25-X	——	——	——	0
aurantifolia	1	1	30	Young	30-X	——	——	——	0
	1	1	30	Medium	30-X	——	——	——	0
	1	1	30	Old	30-X	——	——	——	0
	2	1	30	Young	30-X	——	——	——	0
	2	1	30	Medium	30-X	——	——	——	0
	2	1	30	Old	30-X	——	——	——	0
	3	1	30	Young	30-X	——	——	——	0
	3	1	30	Medium	30-X	——	——	——	0
	3	1	30	Old	30-X	——	——	——	0
	4	1	30	Young	7-XI	——	——	——	0
	4	1	30	Medium	7-XI	——	——	——	0
	4	1	30	Old	7-XI	25-XI	15-XII	1	3.3
	5	1	30	Young	7-XI	——	——	——	0
	5	1	30	Medium	7-XI	——	——	——	0
	5	1	30	Old	7-XI	——	——	——	0
nobilis	1	1	30	Young	7-XI	——	——	——	0
	1	1	30	Medium	7-XI	——	——	——	0
	1	1	30	Old	7-XI	——	——	——	0
	2	1	30	Young	8-XI	——	——	——	0
	2	1	30	Medium	8-XI	——	——	——	0
	2	1	30	Old	8-XI	——	——	——	0
	3	1	30	Young	8-XI	——	——	——	0
	3	1	30	Medium	8-XI	——	——	——	0
	3	1	30	Old	8-XI	——	——	——	0
	4	1	30	Young	10-XI	——	——	——	0
	4	1	30	Medium	10-XI	——	——	——	0
	4	1	30	Old	10-XI	——	——	——	0
	5	1	30	Young	11-XI	——	——	——	0
	5	1	30	Medium	11-XI	——	——	——	0
	5	1	30	Old	11-XI	——	——	——	0

TABLE 7

Effect of callusing the branches of Citrus mitis before planting

Set 1

NUMBER OF CUTTINGS PLANTED	AGE OF BRANCH USED	DATE RINGED	DATE CALLUSED	DATE PLANTED	DATE ROOTED	NUMBER OF CUTTINGS ROOTED	PERCENTAGE
		1928	1928	1928			
60	Young	12–VII	22–VII	27–VII	——	——	0
60	Medium	12–VII	22–VII	27–VII	——	——	0
60	Old	12–VII	22–VII	27–VII	——	——	0

Set 2

60	Young	25–IX	3–X	20–X	——	——	0
60	Medium	25–IX	3–X	20–X	——	——	0
60	Old	25–IX	3–X	28–X	——	——	0

NOTES ON THE TWENTIETH ANNIVERSARY CELEBRATION

In spite of the typhoon signal hoisted at the Manila Observatory, and the consequent squally weather which that indicated, the opening events of the twentieth anniversary celebration of the College of Agriculture on October 10 were attended by a large number of visitors. After the student-body parade in the morning, His Excellency Dwight F. Davis, Governor General of the Philippines, Vice Governor E. A. Gilmore, Chairman of the Board of Regents, President Rafael Palma, and Dean B. M. Gonzalez delivered speeches at a meeting presided over by Dr. N. B. Mendiola, who was chairman of the executive committee for the celebration. On the same morning, the Campus Bridge, Animal Husbandry Gate, Experiment Station Bridge, and Agricultural Education Building were inaugurated with appropriate ceremonies. The sponsors were, respectively, Mrs. Rafael Palma, Mrs. B. M. Gonzalez, Miss Alita Davis, and Miss Alice Davis. Both Dr. A. L. Teodoro, who presided over the inaugural proceedings, and Dr. S. A. Francisco, chairman of the program committee, waxed eloquent when introducing each fair sponsor who enacted the symbolism of cutting the ribbons.

The luncheon for guests and faculty at the Molawin Hall was typical of Los Baños, with its *suman*, *lechon*, and milk flowing a plenty from the Animal Husbandry Dairy, and, of course, a complete line of vitamines from Doctor Santos' laboratory. Charming "co-eds" did the serving.

Like a regular Philippine village fiesta, gay-colored festoons, flags, and palms decorated the public buildings and private residences on the Campus. Band music and, in the evening, fireworks and Tagalog "zarzuelas" enlivened the occasion.

The different departments of the College vied with one another in placing on exhibition instructive, as well as attractive, displays characteristic of their various lines of activities. Some of the principal attractions were the orchid exhibit; improved College copra drier; "Miss Aggie," a pedigreed Cantonese hen with a record of 270 eggs during her first year; electrical appliances for farm and home, and numerous other interesting features. So popular did the exposition prove that it had to be extended to the morning of the fourth day, October 13.

One of the biggest drawing cards of the celebration was the Pageant depicting the development of the College of Agriculture through the twenty years of its existence. The costumes of the participants, representing the characteristics of nine different Philippine regions as well as those of five neighboring foreign countries from which the College has attracted students, formed a colorful array against the background of luxuriant tropical vegetation in the Landscape Garden that served as a natural stage. The characters impersonating Dean Copeland and the late Dean Baker played their parts admirably well, despite the difficulty of portraying true to life the striking traits of their subjects. Even the domestic animals that took part in the Pageant—carabao, horse, and swine—behaved as if they caught the spirit of the occasion. Miss Anne F. Cole, who wrote and directed the performance, proved her mastery of dramatic presentation by the skilful way in which she blended humor and pathos in the various scenes.

The rain spoiled the greater part of the athletic program, but enough games were held to satisfy the public. The results of the events, as reported by Assistant Physical Director R. P. Tolentino, were as follows:

Soccer Football. The Siamese students' soccer football team tied with the Filipino students' eleven. The score was two all. Lemoncito and Austria of the Filipino team scored the first two goals. Not to be outdone, two Siamese players, Punyasingha and Viradeja, evened up the count by making one goal each before the final whistle blew. An extra five minutes of play did not change the total score for either team.

Veterinary-Forestry Dual Meet. In volley ball, the Veterinary team won an uphill match from the Forestry team. The Rangers started well by capturing the first set, 17-21. But the Veterinarians came back strong and won the second and third sets, 22-20 and 21-5.

However, in the half-mile relay, the Foresters proved themselves better runners than the Veterinarians. Ledesma, first runner of the winning team, made a comfortable lead which his team mates, Caayupan, Juni, and Cagalawan, maintained to the tape.

Three-Mile Run. Nine students entered in this classic event, of whom only one failed to finish. First, second, and third places went to Yatar, Enriquez, and Tuya, respectively. The five others who finished the race covered the distance in good enough time to entitle them to receive consolation prizes. Yatar, intramural record holder for the event, not only walked away with the race but also improved his old time by almost one minute. His unofficial time was 16 minutes and 20 seconds. In the following order they breasted the tape:

1st.	Pedro Yatar	(C.A. '32)
2nd.	Eleuterio Enriquez	(C.A. '32)
3rd.	Manuel Tuya	(C.A. '30)
4th.	Perfecto Boncato	(C.A. '30)
5th.	Roberto Tirol	(C.A. '32)
6th.	Pedro Lorenzo	(C.A. '33)
7th.	Olimpio Alcántara	(C.A. '33)
8th.	Nicanor Manipula	(C.A. '33)

In the military drill competition for the Brias-Roxas Cup for 1929, according to Assistant Commandant José E. Olivares, Company "C" was declared winner by General Order No. 3 of the Department of Military Science and Tactics. The scores of the competing companies were as follows:

Company "A"	114 points
Company "B"	118½ points
Company "C"	122½ points

The officers of Company "C" were Cadet Capt. W. Tingzon, commanding; Cadet First Lieut. C. Mariano, second in command; Cadet Second Lieut. V. R. Garcia, commanding first platoon; Cadet Second Lieut. L. Aldea, commanding second platoon; Cadet Second Lieut. A. Madarang, commanding third platoon. The judges in the competition were Major R. A. Gillmore, U. S. A., Lieutenant Commander J. E. Williams, U. S. N., and Capt. F. V. Segundo, U. S. A.

It was a source of pride and particular satisfaction for the College to see many of her alumni, from the earliest to the most recent graduating classes, come to strengthen their ties with their Alma Mater. Some of these, owing to assignment in distant places, visited the Campus for the first time since graduation and found themselves bewildered unless accompanied by guides, so great and rapid has been the change in construction of buildings, roads, and other improvements during recent years.

On Friday night, a torchlight parade preceded the *zarzuela*. Hundreds of students, including the girls, and some faculty members participated. All bore torches, and the twinkling lights, as the procession wound its way up and around Faculty Hill, presented a glorious spectacle that even Maria Maquiling, looking down from her mysterious abode in the mountain fastnesses, must have enjoyed.

The last day of the celebration, Saturday, October 12, closed with the Seniors' Reception. The seniors acquitted themselves creditably with a well managed ball in the College Auditorium.

A REVIEW: POULTRY RAISING

A text book for students and a guide for all who raise poultry. By F. M. Fronda, Ph. D. (Cornell). Assistant Professor of Poultry Husbandry, University of the Philippines. 269 pages, 61 illustrations. Published by Oriental Commercial Company, Inc., Manila, 1928.

This book was written after the author had had extensive experience in poultry raising both from the theoretical and practical standpoints. A visit to the Poultry Division of the Department of Animal Husbandry of the College of Agriculture, University of the Philippines, of which Doctor Fronda is in charge, will convince one that the author handles the practical phase of his subject quite effectively. During the last seven years he has very zealously applied himself to the study of poultry problems in our country. Already he has carried out to happy completion the project started by Dr. B. M. Gonzalez, head of the Department, some thirteen years ago, of developing a breed of chicken adapted to Philippine conditions.

In this book Doctor Fronda has put his ideas in very readable form. As typical illustrations the following may be given: (1) Under the heading, Feeding the Growing Stock (page 56), he says, "Young chicks kept on a wide run may be fed either cracked corn or palay or both, and a mash mixture composed of one part each by weight of rice bran, of rice shorts, of corn meal, of copra meal, and of dried shrimps. This mixture should be available to the birds all day. If shrimps cannot be secured, some form of meat food, as ground snails or white ants, should be given. Fresh table scraps may also be given. If the runs have abundant vegetation, the chicks may get enough insects and worms to supplement the feed given them". (2) In another place (page 87) under the heading, Breaking Up Broodiness. he says, "Various methods of breaking up broodiness, as starving the broody hen, dipping her in cool water, applying salt or ground pepper or both on the vent, or other means, have been recommended. These treatments, besides being inhumane, do not always work, and the hens so treated do not generally lay again for some time. A satisfactory method is to confine the broody hens in a roomy, well ventilated compartment provided with a hard floor made either of bamboo, wooden slats, concrete or earth packed hard. While confined, the hens should be given plenty of wet mash or soft nourishing food. Hens so treated soon after they show broodiness will lose their desire to sit after about four days, and will begin to lay a week or two after they are let loose or returned to the pens".

The subject matter of poultry raising is presented by Dr. Fronda in twenty chapters. Each chapter contains a summary of the materials covered, a set of questions for review, and suggestions for laboratory work for those who may be teaching poultry raising in agricultural schools. Pertinent data were taken from the publications of the Philippine Education Company, entitled, *Agricultural Clubs for Filipino Boys and Girls*, are appended. The book is well illustrated and contains extensive bibliography and index. At the present time, when vocational education and particularly the agricultural phase of this education is the subject of talk in practically every circle in the Islands, the publication of books such as this is quite timely. Dr. Fronda's book should be a useful text book not only for students but for all who may be directly or indirectly interested in the development of the poultry industry in the Philippines.

MIGUEL MANRESA
Assistant Professor of Animal Husbandry.

ORCHID EXHIBITS IN THE 1929 EXPOSITION OF THE COLLEGE OF AGRICULTURE[1]

N. B. MENDIOLA
Of the Department of Agronomy

WITH TWO PLATES

One of the important features of the exposition held by the College of Agriculture on October 10 to 12, 1929, to celebrate the twentieth anniversary of the foundation of this institution, was an exhibition of Philippine and foreign orchids, varieties ornamental as well as those primarily of botanical importance. The College itself and a number of private orchid collectors and growers had plants on exhibition.

It was at the writer's suggestion that this orchid show was held, his object being to create among resident orchid fanciers in the Philippines a more general interest in orchid collecting and orchid growing and to give the general public a greater knowledge of the number and kinds of orchids which may be collected or grown, as well as of the various methods of culture used by different growers. Some of the rarest and most beautiful orchids in the world are natives of the Philippines; however, the pride and pleasure of their possession have so far been confined mostly to residents of Europe, America, Japan, Java, and other foreign countries, and this possession has been of very long duration.

The exhibits belonged to the College of Agriculture and to the following private owners; Mr. E. Ermitaño, Mr. Macario Gibe, Mrs. N. B. Mendiola, Mrs. Florencio Soliven, Mrs. Carlos Sulit, Mr. Mamerto Sulit, and Mr. Moises Villaluz.

It was not possible to house all the exhibits in one single booth because several of the private exhibitors whose orchids are in greenhouses located on the Faculty Hill were not willing to move their orchids to the main exposition grounds and run the risk of losing or damaging some of their plants. However, these greenhouses are located very near one another on the Faculty Hill, which is but a few minutes ride from the College proper.

It might be of interest to report briefly on the method of some exhibitors of keeping their orchids. The College orchids are kept in a greenhouse built on a frame of galvanized iron pipe, the frame work being covered with ordinary netted fence wire and split bamboo and these in turn partly covered with several species of vines such as *Allamanda cathartica* Linn.

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[1] Experiment Station contribution, No. 632.

and *Bignonia magnifica* Bull. It is quite shady inside this structure where are also found growing well other shade-loving ornamental plants, such as Begonia, Anthurium, Caladium, ferns, and others.

The orchids of Mrs. Mendiola, Mrs. Soliven, and Mr. Villaluz are kept in and around greenhouses constructed wholly of bamboo, that is, of bamboo frame, roofing and wall, the roofing and wall being of split bamboo pieces about three centimeters wide and placed one or two centimeters apart. The orchids of Mrs. Sulit are kept under a grove of forest trees and below the eaves of her house. Mr. E. Ermitaño keeps his orchids in Manila suspended on stone walls of a small, cement-floored yard which is shaded about half of the daytime. This orchid seller, I understand, also has a simple glass house in Silang, Cavite province, where most of his orchids are found. The writer has not seen the greenhouse in Silang.

The different methods of orchid growing observed in the exhibitions should also be of interest. The practices of some of the exhibitors were quite a revelation to others, and to the public as well. The *mariposa* orchids, the common native name for various sub-varieties and forms of *Phalaenopsis amabilis* (Linn.) Blume var. *aphrodite* (Reichb. f.) Ames were seen attached either to the base of the bird's nest fern, *Asplenium nidus* Linn., to a piece of wood with (Plate 1, fig. 2) or without Sphagnum moss or coconut husk fiber or to a piece of cork bark. The use of cork (Pl. 2, fig. 5) is of recent practice in the Philippines. One advantage claimed for it is that it does not encourage pests and diseases of the orchid specially during the wet season. Other species of *Phalaenopsis*, including *P. schilleriana* Reichb. f., commonly known as "tigre," meaning "tiger orchid," were found grown as the *mariposa*. In the case of *P. schilleriana*, however, the curious fact was observed that it is also grown as a ground orchid, not exactly grown in the ground, but planted in soil which is contained in pots made of coconut husk. (Plate 2, fig. 3.) In this medium the roots do not all stay in the soil, but part of them are outside, clasped to the pot. Most of the air orchids in the exhibition were simply attached to pieces of wood with their roots partly or not at all covered with coconut husk fiber. In the College greenhouse, many of them are grown in wire or wooden baskets containing Sphagnum moss. A group of six plants of *Vanda luzonica* Loher was shown growing in a wooden basket containing pieces of soft stone. Two plants of *Vandopsis lissochiloides* (Gaudich.) Pfitz. were exhibited growing in an earthen pot containing pieces of stone and cork wood. A clump of *Vanda lamellata* Lindl. var. *boxalli* Reichb. f., was seen in a wooden basket without any other solid thing inside. In one collection a number of earthen orchid pots are in use, mostly for growing *Phalaenopsis schilleriana*. Ordinary earthen pots containing soil are used for ground orchids like *Spathoglottis plicata* Blume, *Phajus grandifolius* Lour. (*Bletia tankervilliae* R. Br.) (Pl. 2, fig. 6), *Arundina bambusaefolia* Lindl. *Thunia marshalliana* Reichb. f., species of *Cordula* (*Cypripedium*), and also for a few air orchids like the *Cymbidium*, but in the case of the last coconut husk fiber is used instead of soil.

No less than one thousand individual orchid plants divided among approximately one hundred species and coming from nearly all provinces of the Philippines were included in this orchid exhibit. Considering that there are about eight hundred fifty known species of orchids in this country, the number shown is encouraging, bearing in mind that this exhibition is, as far as the writer is aware, the first of its kind held in the Philippines. Even if more orchid enthusiasts had taken part in the exhibition, the number of species would not have been increased perceptibly. Many of the species are not of much ornamental value although of great botanical interest.

A number of the beautiful orchids which would have been more admired when in flower were not in bloom at all at that season. Such was the case with *Vanda sanderiana* Reichb. f., which had finished flowering only about one week before the event; also the *tigre* orchids, *Phalaenopsis schilleriana; Vanda luzonica; Vanda lamellata;* several species of *Dendrobium; Grammatophyllum speciosum* Blume and *G. scriptum* (Lindl.) Blume and a number of others.

A brief description of the more valuable species which were shown in flower might be of interest to Philippine readers.

Phalaenopsis intermedia Lindl. var. *portei* Reichb. f.—This is considered one of the rarest orchids of the Philippines, if not of the world for that matter, and believed to be a natural hybrid between *P. equestris* (Schauer) Reichb. f., and *P. amabilis.* Only one plant was exhibited, and that by Mr. Ermitaño. This plant was in a cork basket. The individual flower differs mainly from that of some ordinary *P. amabilis* forms in that the entire lip is colored purplish rose. Its sepals and the rhomboid petals are white, tinged with light rose, but so are the flowers of some common *P. amabilis.* A certain commercial nursery in Manila once sold a plant of *portei* in flower, it is said, for two hundred pesos. The one exhibited in the College exposition had only a few open flowers and it was priced at seventy-five pesos.

Phalaenopsis intermedia Lindl. var. *brymeriana* Reichb. f. (Plate 1, fig. 1.)—Some orchidists consider this the rarest and most highly prized Philippine orchid. Five plants were on exhibition, but only one of them was in flower. Two plants in a basket, one smaller than the other, were priced at one hundred and twenty pesos. In habit of growth this species does not differ much from other *Phalaenopses.* The leaves are somewhat harder, and are slightly speckled. The lateral sepals of the flower are spotted with purple at the base, while the petals have much smaller spots of rose. In the form exhibited the lip is not as solidly colored as in other forms which have been described.

Phalaenopsis amabilis (Lindl.) Blume var. *aphrodite* (Reichb. f.) Ames sub-var. *sanderiana* (Reichb. f.) Ames forma *alba* (Veitch) Ames.—This is another of the very rare Philippine orchids. Only two plants were seen in the exhibition. The flowers are much larger than those of many species of *Phalaenopsis* but do not differ from other species in other important respects. This form is distinguished from others mainly in having very broad, thick, rounded leaves, the upper surface of which is dark silver-gray.

Phalaenopsis stuartiana Reichb. f.—This is one of the fairest Philippine *Phalaenopses.* According to the Orchid Review (1926, **34**: 312), this species was discovered by Boxall near Surigao in 1881 and named in honor of Mr. Stuart Low, an orchid grower. Several plants in flower were exhibited. This species is characterized mainly by the freckles and transverse gray blotches on the upper surface of the leaves, these blotches disappearing with age. In this respect it is similar to *P. leucorrhoda* Reichb. f. The flowers are quite distinct from those of other *Phalaenopses.* They are white, but the inner half of the lateral sepals and lip are spotted with reddish purple. Another *Phalaenopsis* exhibited in flower was *P. equestris* (Shauer) Reichb. f. Four forms of the species were observed. Other species of the same genus exhibited were *P. lueddemanniana* Reichb. f. and *P. leucorrhoda* including the variety *cynthia,* but they were not in bloom.

Of *Aerides* species, the two commercial ones, namely, *Aerides lawrenciae* Reichb. f. and *A. quinquevulnerum* Lindl. were in exhibition. However, only the first was in flower. *A. lawrenciae* is found in Mindanao. It produces larger flowers than *A. quinquevulnerum* but are not fragrant. At least four forms are known, one with dark purple flowers, another with white flowers but marked with magenta, another like the second with the side lobes of the vertical petal spotted with the same color, and another also white but marked with orange. Plants of the other forms were also in the collection shown.

The Philippine *Dendrobium* is second only to *Bulbophyllum* in number of species. It is supposed to include seventy-seven Philippine species. Of these, *D. anosmum* Lindl., *D. dearei* Reichb. f. (Plate 2, fig. 4), *D. heterocarpum* Wall., *D. taurinum* Lindl., *D. secundum* Wall., *D. topaziacum* Ames, *D. crumenatum* Sw., and *D. lyonii* Ames, all Philippine, are of ornamental value. Several plants of *D. taurinum* bearing flowers different from those found in Laguna province were exhibited. A beautiful foreign *Dendrobium, D. phalaenopsis* Fitzgerald (Plate 2, fig. 5), was seen in the booth of private exhibits. It had flowers about five centimeters across and reddish purple in color.

That the small size of the flower does not necessarily prevent an orchid from being ornamental is shown by the species *Kingiella philippinensis* (Ames) Rolfe. The flowers of this species are vey small, only a few millimeters in diameter, but because of their form and conspicuous color and because they are produced all the year round, this species has ornamental value. One collection showed five clumps of this orchid, each clump growing in a pot made of coconut husk and each plant bearing two flower stalks.

A few words should be given to the largest Philippine orchid genus, *Bulbophyllum*. This genus is supposed to include one hundred nine species. It is curious, however, that not a single Philippine species of this genus has come to any commercial importance, the main reason for this being the smallness of its flower. A number of specimens were exhibited, one of those in flower being *B. whitfordii* Rolfe.

Besides *Dendrobium phalaenopsis*, a number of other orchids of foreign origin were included in the exhibition, those in flower at the time being three forms or varieties of *Spathoglottis plicata* from Java, the purple, the white, and the pink, and several plants of *Arundina bambusaefolia* Lindl.

The following is a list of the species which were exhibited and which the writer was able to recognize. There was a number of the species shown which were unknown by name to the writer. Those marked with an asterisk are at present of commercial or ornamental value.

NATIVE

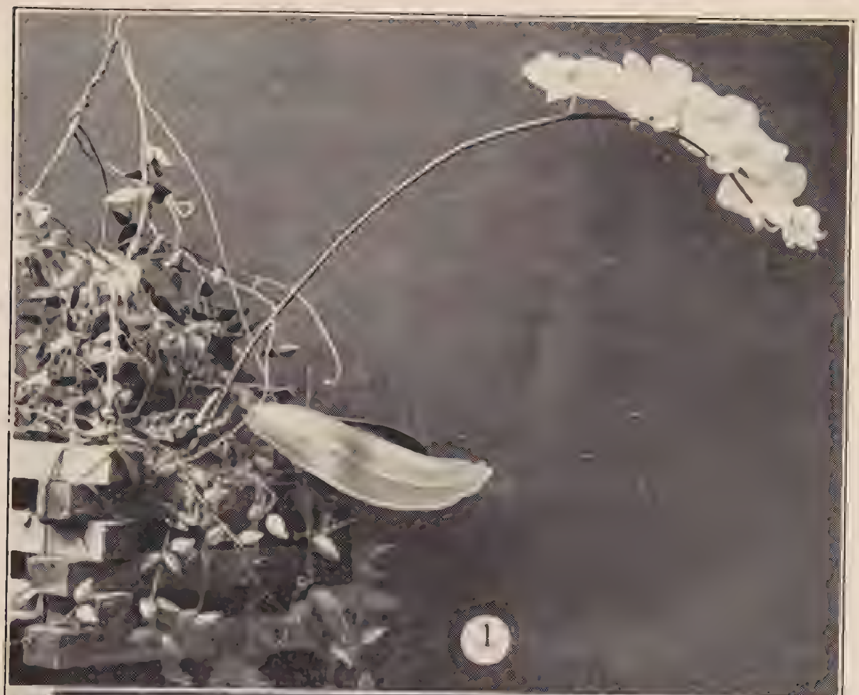
Adenostylis luzonensis Ames
**Aerides lawrenciae* Reichb. f.
**Aerides quinquevulnerum* Lindl.
Agrostophyllum sp.
Appendicula perplexa Ames
Ascocentrum miniatum (Lindl.) Schltr.
Bulbophyllum adenopetalum Lindl.
Bulbophyllum whitfordii Rolfe
**Calanthe furcata* Batem. ex Lindl.
Camarotis philippinensis Lindl.
**Cordula argus* (Reichb. f.) Rolfe
**Cordula ciliolaris* (Reichb. f.) Rolfe
**Cordula haynaldiana* (Reichb. f.) Rolfe
Cryptostylis arachnites (Blm.) Hassk.
**Cymbidium atropurpureum* (Lindl.) Rolfe
**Cymbidium finlaysonianum* Lindl.
Dendrobium albayense Ames
**Dendrobium anosmum* Lindl.
Dendrobium aporoides (Lindl.) Merr.
**Dendrobium crumenatum* Sw.
**Dendrobium dearei* Reichb. f.
Dendrobium distichum (Presl.) Reichb. f.
**Dendrobium heterocarpum* Wall.
**Dendrobium lyonii* Ames
**Dendrobium papilio* Loher
Dendrobium platycaulon Rolfe
Dendrobium plicatile Lindl.
**Dendrobium secundum* Wall.

**Dendrobium taurinum* Lindl.
**Dendrobium topaziacum* Ames
Dendrobium uniflorum Griff.
**Dendrobium ventricosum* Kranzl.
Dendrochilum uncatum Reichb. f.
Eria javanica (Sw.) Blume
**Eria ornata* (Blume) Lindl.
Eria polyura Lindl.
Eria ventricosa Leavitt
Eria vulpina Reichb. f.
**Grammatophyllum scriptum* (Linn.) Blume
**Grammatophyllum speciosum* Blume
**Kingiella philippinensis* (Ames) Rolfe
Liparis longipes Lindl.
Malaxis acuminata D. Don Prodr.
Nervilia discolor (Blume) Schltr.
**Phalaenopsis amabilis* (Linn.) Blume var. *aphrodite* (Reichb. f.) Ames
**Phalaenopsis equestris* (Schauer) Reichb. f.
**Phalaenopsis intermedia* Lindl. varieties *portei* and *brymeriana* Reichb. f.
**Phalaenopsis leucorrhoda* Reichb. f.
**Phalaenopsis lueddemanniana* Reichb. f.
**Phalaenopsis schilleriana* Reichb. f.
**Phalaenopsis stuartiana* Reichb. f.
Pholidota imbricata Lindl.
Platyclinis filiformis Benth.
Plocoglottis sp.
Pomatocalpa latifolium (Lindl.) J. J. Sn.
Pomatocalpa vitellinum (Reichb. f.) Ames
**Renanthera imschootiana* Rolfe
**Renanthera monachica* Ames
**Renanthera storiei* Reichb. f.
**Rhynchostylis retusa* (Linn.) Blume
Sarcanthus dealbatus (Lindl.) Reichb. f.
Sarcanthus pachyphyllus Ames
**Sarcochilus pallidus* (Blume) Reichb. f.
**Spathoglottis plicata* Blume
Thrixspermum sp.
Trichoglottis sp.
**Trichoglottis philippinensis* Lindl.
Trichoglottis wenzelii Ames
**Vanda lamellata* Lindl.
**Vanda lamellata* Lindl. var *boxalli* Reichb. f.
**Vanda limbata* Blume
**Vanda luzonica* Loher ex Rolfe

**Vanda sanderiana* Reichb. f.
**Vanda superba* Lindl. var *boxalli* Reichb. f.
**Vandopsis lissochiloides* (Gaudich.) Pfitz.

FOREIGN

**Arundina bambusaefolia* Lindl.	
**Bletia tankervillae* R. Br.	Java
**Dendrobium fimbriatum* Hook	India
**Dendrobium nobile* Lindl.	India
**Dendrobium phalaenopsis* Fitzgerald	New Guinea
**Oncidium sarcodes* Lindl.	Brazil
**Saccolabium giganteum* Lindl.	India
**Spathoglottis plicata* Blume var. *alba*	Java
**Spathoglothis plicata* Blume var. *intermedia*	Java
**Spathoglottis plicata* Blume var *purpurea*	Java
**Thunia marshalliana* Reichb. f.	China
**Vanda miss joaquium*	Singapore
**Vanda teres* Lindl.	Singapore
**Vanda tricolor* Lindl.	Java



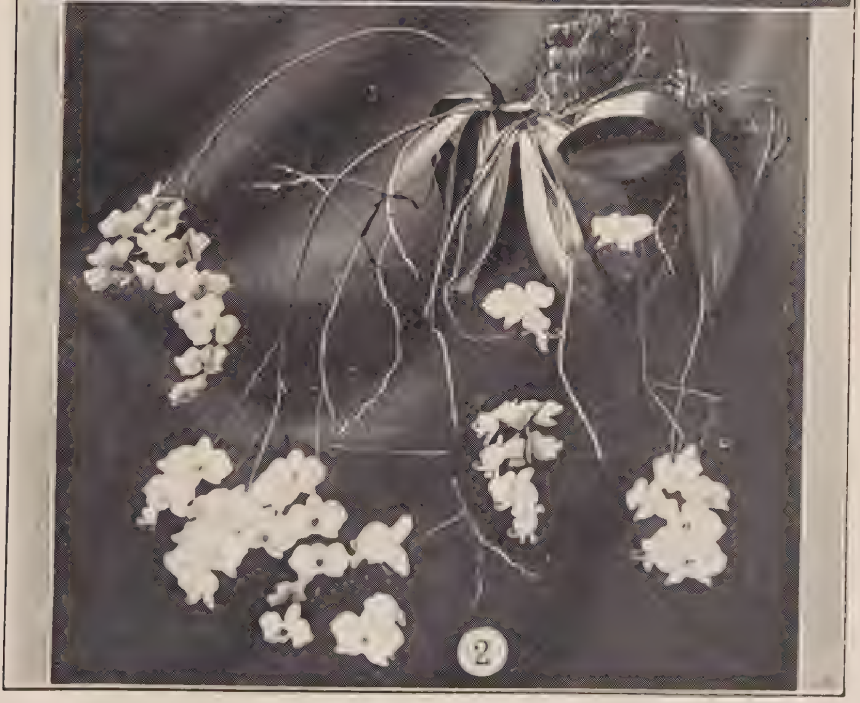
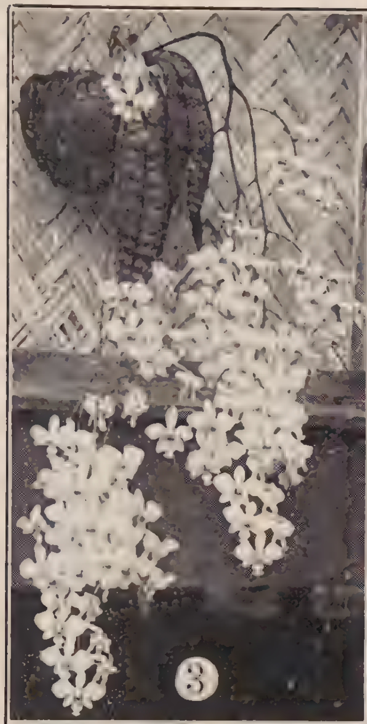
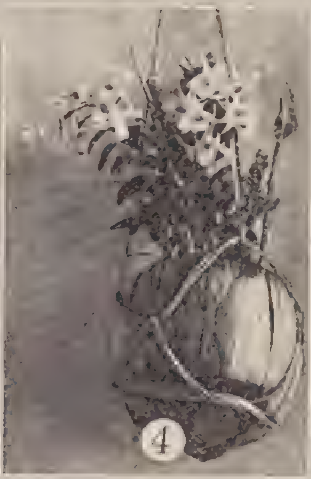


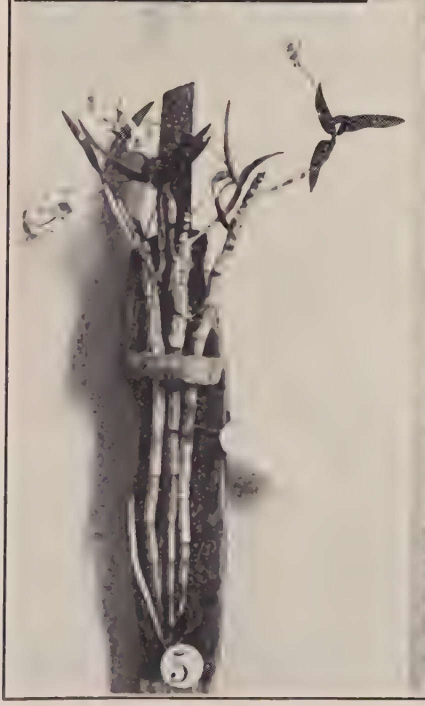
PLATE 1

Fig. 1. *Phalaenopsis intermedia* Lindl. var. *brymeriana* Reichb. f. growing in a wooden basket containing Sphagnum moss.

Fig. 2. *Phalaenopsis amabilis* (Linn.) Blume var. *aphrodite* (Reichb. f.) Ames growing attached to a piece of wood covered with coconut husk.







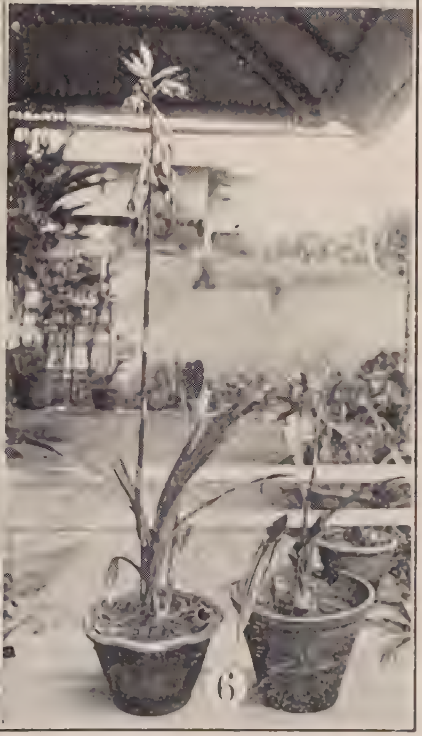


PLATE 2

Fig. 3 *Phalaenopsis schilleriana* Reichb. f. growing in a basket made of coconut husk and containing ordinary garden soil.

Fig. 4 *Dendrobium dearei* Reichb. f. growing in a basket made of coconut husk with coconut fiber inside.

Fig. 5 *Dendrobium phalaenopsis* Fitzgerald growing attached to a piece of cork bark.

Fig. 6 *Phajus grandifolius* Lour. growing in soil in an ordinary garden pot.

THE COST OF PRODUCING MILK AT THE COLLEGE OF AGRICULTURE[1]

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The object of this study is to determine the cost of producing milk at the College of Agriculture where carabaos, Indian buffaloes, Hereford, Native and Nellore cattle and their various grades are used for milk production. The data presented are based on the record of production of the College dairy herd from January 1 to December 31, 1927.

MATERIALS AND METHODS

Animals

Altogether twenty-seven cows contributed the total amount of milk produced reported in this paper. (See table 1.) Of this number five were carabaos, three were Indian buffaloes, four were Indian buffalo-carabao crosses, six were Native cows, two were Indian Nellores, one was Hereford, and six were grade cattle. On an average, there were 15.5 cows that were actually milking all the time. These represent about fifty-seven per cent of the total number of cows in the herd.

The milk was practically all sold as mixed whole milk, the average test being about five per cent of butter fat.

The cost items that comprise the charges or costs chargeable to the cows are the following:

1. Labor
2. Feed
3. Use of buildings
4. Use of equipment
5. Cow and bull cost
6. Miscellaneous charges

The net income was determined by subtracting the above mentioned charges from the gross income which was derived from two sources, namely, (a) milk and (b) calf crop.

Rate of interest, depreciation, tax, insurance, and repairs

Interest. The rate of interest used for money invested was 6 per cent.

Depreciation. The rate of depreciation used for the dairy barn and milk was 3.3 per cent, assuming that these buildings, being of concrete, will

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be good for thirty years. The rate used for equipment was 20 per cent. Many of the articles listed under equipment will probably last more than five years, but because no allowance was made for insurance and repairs this high charge of 20 per cent for depreciation seems justified.

Tax. The rate of tax used for building and for land were 0.5 and 0.88 of one per cent, respectively, of their assessed value.

Insurance. The rate of insurance used for animals was 5 per cent and for buildings 0.25 per cent.

Repairs. For repairs of buildings the rate used was 2 per cent.

CHARGES OR COSTS[2]

Labor

In operating this dairy project the services of four men were employed. The two men who were in charge of the dairy herd were the same persons who milked the cows and delivered the milk to the customers. The other two were student laborers who worked in the milk room from three to four hours each a day. Their principal duty was to clean and sterilize milk bottles, pails, and all dairy utensils that they used, and to bottle the milk.

There was an average monthly expense for labor alone amounting to ₱108.91. Of this amount about 25 per cent was paid to the milk room men and 75 per cent to the herdsmen.

Labor is the largest cost item, amounting to ₱1,306.90 or about 43.53 per cent of all the charges.

Feed

In the feed charge were included the cost of (a) pasture, (b) grain, and (c) salt. About 94 per cent of the feed charge was pasture cost and only about 6 per cent was cost of grain and salt combined. The pasture cost alone is about 32 per cent of all the charges.

Munger (1921), in studying the cost of milk production on 58 farms near Mason City, Cerro Gordo county, Iowa, found that the feed cost was 59.2 per cent of the gross cost, the largest item of all charges. In the College of Agriculture, however, this was only second, being about 35 per cent of the gross cost, or 24 per cent lower than the finding by Munger. This difference can be accounted for by the fact that our animals were dependent mostly on pasture for their subsistence, and being low yielders a small amount of grain was sufficient for them. On the other hand, in the United States grain constitutes the largest single item of the feed of dairy animals.

Use of buildings

The construction of dairy barn and milk room cost the College ₱2,406. Charging 6 per cent for interest, 3.3 per cent for depreciation, 0.5 per cent for tax, 0.25 per cent for insurance, and 2 per cent for repairs the buildings have an annual value of 12.05 per cent of its cost, or ₱289.92. This amount, therefore, represents the charge for the use of the buildings.

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[2] See table 2.

Use of equipment

The total cost of equipment was ₱130.94. The cost of its use was estimated by taking 26 per cent of its value, comprising 6 per cent for interest and 20 per cent for depreciation or ₱340.44

Cow and bull cost

What constituted the cow and bull cost was the 11 per cent charge for insurance and interest of the total investment on twenty-seven cows and two bulls. The average cost per head of carabao, Indian buffalo and ox cows was placed at ₱100 or ₱2,700 for all the cows. The carabao and ox bulls were each valued at ₱250. Hence, the cost of the entire herd was ₱3,200. Eleven per cent of this, or ₱352, gives the cow and bull cost. This amount represents about 12 per cent of the total charge, the third of all the items of expense. There was no charge made for the depreciation of these animals inasmuch as some of them were depreciating while the others were appreciating in value.

Miscellaneous charges

Table 2 shows the item of expenses listed under miscellaneous charges. In this the biggest single item was ₱25.68 spent for absorbent cotton used for plugging the small-mouth milk bottles. The next large item was ₱21.50 spent for kerosene. The miscellaneous expenses totaled ₱83.28, which was 2.6 per cent of the total charges.

The cows were not charged for bull service nor the bulls credited for it or for other work inasmuch as all the expenses for the feeding and care of the bulls were already charged to the cow.

SOURCES OF INCOME

Milk

During 1927, the total amount of milk produced was 7,241.91 liters. Of this amount, 1,275.26 liters, or 17.61 per cent, was obtained from carabaos; 977.08 liters or 13.49 per cent, from Indian buffaloes; 1,981.04 liters, or 27.35 per cent, from Indian buffalo-carabao crosses; 619.78 liters, or 8.56 per cent, from Native cattle; 398.20 liters, or 5.5 per cent, from Nellores; 160.41 liters, or 2.21 per cent, from Herefords, and 1,830.14 liters, or 25.27 per cent, from grade cattle. The milk alone brought in a gross income of ₱3,041.34 for the entire year.

Calf crop

In the calf crop were included only those calves that were born during 1927 and were still alive at the end of that year. On December 31, 1927, there were altogether 21 of these calves. Of this number, five carabao calves weighed 432.14 kilograms; three Indian buffalo calves weighed 251.28 kilograms; one Indian buffalo–carabao cross weighed 117.90 kilograms; four native calves weighed 229.85 kilograms; two Nellore calves weighed 260.28 kilograms; and six grade calves weighed 567.55 kilograms. The total weight of the calf crop was 1,823 kilograms. At 25 centavos per kilogram live-weight the calf crop was worth ₱455.75.

Combining the income from milk with that from the calf crop, we have a total gross income of ₱3,497.09.

COST OF PRODUCING ONE LITER OF MILK

To produce 7,241.91 liters of milk cost ₱2,710.44. This amount was obtained by subtracting ₱455.75, the amount credited to the cows for the value of the calf crop, from the total gross charge of ₱3,166.19. Basing computation on these figures, it cost 37.43 centavos to produce one liter of milk.

In the dairies of Cerro Gordo county, Iowa, according to Munger (1921), the average cost of producing one liter of milk was the equivalent of 14.31 centavos, Philippine currency, while in the California dairies, according to Adams (1923), it cost 12.57 centavos. Comparing our cost of production in the College of Agriculture, with these figures, shows that to produce one liter of milk cost us about two and a half times as much as it cost the former, and about three times as much as the latter. This was so in spite of the fact that our labor and feed costs for each cow here were very much less than those in the States. The average labor cost for each cow in the College dairy was ₱45.06, whereas in the Cerro Gordo county dairies, and in the California dairies it was ₱70.20 and ₱104, respectively. The average feed cost each cow in our dairy was only ₱40.74 while in the Cerro Gordo county dairies it was ₱188, or more than four times as much as in our dairy, and that of the California dairies was ₱198.28, or about 5 times as much as in our dairy. But why was there so much difference in the cost of production? This can be accounted for mainly by the fact that our milking animals are much less efficient producers than the improved dairy cows of the United States, as shown by their performance. Taking the milking herd as a whole, the average production for each cow in the College of Agriculture was 268 liters while that in the Cerro Gordo county was 1,928 liters and that in the California dairies was 3,162 liters. In other words, our animals as milk producers are less than one seventh as efficient as those in the Cerro Gordo county dairies and less than one-eleventh as efficient as those in the California dairies.

WILL IT PAY TO KEEP THE CARABAOS, THE INDIAN BUFFALOES, THE NATIVE AND NELLORE CATTLE AND THEIR VARIOUS GRADES AS MILK ANIMALS?

Like other business enterprises, the question of making or not making profit in dairying depends largely upon the relation between cost of production and the selling price of the product which the majority of the consumers is willing to pay. As mentioned in the above discussion it cost us about 37 centavos to produce one liter of milk. This is more than twice as high as in the United States. Notwithstanding this very high cost of production, dairying in the Philippines, even with a mixed herd similar to that of the College, is a profitable business for the reason that here fresh milk commands a very much higher price. In Lipa, Batangas, it sells at 75 centavos and in Manila the price ranges from ₱0.80 to ₱1.25 a liter. In the College of Agriculture it sells at 40 to 60 centavos a liter.

During 1927, the College of Agriculture dairy sold 7,241.91 liters of milk for ₱3,041.34. Therefore it can be said that this milk was sold at the average rate of about 42 centavos a liter. The cost of producing one liter of milk being 37.43 centavos and the selling price 42 centavos a liter, a net profit of 4.57 centavos from every liter of milk was realized, or a total net income of ₱330.95 from 7,241.91 liters. This amount is what is generally considered as the managerial income.

If milk is to be sold at Lipa at 75 centavos a liter, a net income of ₱2,720.99 would be realized, giving about 86 per cent dividend. On an average of ₱1.00 a liter a net income of ₱4,531.73 would be realized, or a dividend of about 143 per cent. The net income is therefore increased more than eight times when the price is raised from 42 to 75 centavos a liter, and more than thirteen and one half times when the price is raised to ₱1.00 a liter.

EFFICIENCY OF EACH KIND OF ANIMAL IN THE COLLEGE MILKING HERD COMPARED

After considering as a unit the College milking herd which is composed of various kinds of animals, it would be of interest to know which of the different classes would yield the owner the greatest return. While it is possible to secure record of the separate income from each kind of animals, there is none that directly shows the separate charges to each class. The writer has attempted to overcome this obstacle by assuming that the charge each head, irrespective of the kind of animal, was the same in all cost items except in the case of feed and in the cow and bull cost. In these cost items the charges were distributed by using the weight of the animals as a basis.

Table 3 shows the average net return or loss from one cow per year from each kind of animals. If the selling price of milk is kept at 42 centavos per liter, in one year, on an average, an Indian buffalo cow will give a net return of ₱19.09; an ½ Indian buffalo–½ carabao cow, ₱84.06; a Nellore cow, ₱6.15; and a grade cow, ₱44.92. On the other hand, on an average a carabao cow will hardly pay for its keep, while the native and Hereford cows will each cause a loss to the owner amounting to ₱49.14 and ₱47.08, respectively. Judging from these figures, it is obvious that the ½ Indian buffalo–½ carabao cow gave the highest return, being almost four and one half times more profitable than the Indian buffalo. Grade cattle were the next, returning over seven times as much as the Nellore, and more than twice as much as the Indian buffalo. Not much significance can be attached to the Hereford's figure for there was only one animal under consideration.

The cost of producing one liter of milk varied with the different kinds of animals, as influenced by (a) milk production, (b) calf crop, and (c) charges against the cow.

(*a*) *Milk production.* Of the three factors mentioned above, milk production is the one that affects the cost of production most. As shown in table 3, in one year, the average production each cow among the carabaos was 255.05 liters; Indian buffalo, 325.69 liters; the Indian buffalo–carabao cross, 495.26 liters; Native cattle, 103.29 liters; Nellore 199.10 liters; the Hereford, 160.41 liters, and grade cattle, 305.02 liters. The highest production was made by the ½ Indian buffalo–½ carabao cow and the lowest, by native cattle. The average production each cow of the ½ Indian buffalo–½ carabao was 240.21 liters more than that of the carabao and 169.57 liters more than that of the Indian buffalo. Among cattle the highest production was made by the grades which was 201.73 liters more than that of the native, 105.92 liters more than the Nellore, and 144.61 liters more than the Hereford.

The data presented above only approximates the relative capacity of each class of animals, and is not the true production inasmuch as the stage of lactation varied with the different cows in the herd.

(*b*) *Calf crop.* The fact that milk in the Philippines commands a much higher price than the calf being raised by the cow, it follows that the calf crop will not much influence the cost of production. The calves are raised mainly to take the place of the old ones. Moreover, Villeges and Peña (1926) report that we cannot always be sure of maintaining the productivity of the cows if the calves are removed soon after birth as a number of the dams cease to secrete milk if their young are weaned soon after freshening.

(*c*) *Amount charged to the cow.* As mentioned previously, the different cost items charged to every cow are practically the same except in the case of feed and cow and bull cost. But a more expensive cow or a cow that has a high feed bill and consequently high gross charge is not necessarily an uneconomical producer. What really determines whether or not she is an economical or uneconomical yielder is her record of production.

Referring again to table 4, it may be noted that all the highest producers are the cows that can produce one liter of milk at the least cost, and all the lowest producers, at the maximum cost, without regard to whether they have high or low gross charges, or high or low return from the calf crop. For example, the ½ Indian buffalo–½ carabao gave next to the highest amount of charge and had the lowest return from calf crop. But because she has the highest milk production she was able to produce one liter of milk at a cost of only about 25 centavos, the lowest cost of production in the whole herd. On the other hand, the native cow, in spite of the fact that she had the lowest amount of charge, and had a higher return from the calf crop than the former it cost her almost 90 centavos to produce one liter of milk, the highest cost of production in the herd. This is more than three and one half times as much as it cost the ½ Indian buffalo–½ carabao cow.

In the order of economy of production the different kinds of animals in the milking herd of the College of Agriculture may be listed as follows: First, ½ Indian buffalo–½ carabao, 25 centavos a liter; second, grade cattle, 27 centavos a liter; third, Indian buffalo, 36 centavos a liter; fourth, Nellore, 39 centavos a liter; fifth, carabaos, 42 centavos a liter; sixth, Hereford, 71 centavos a liter; and seventh, native cow, 90 centavos a liter.

SUMMARY

1. The cost of producing one liter of milk at the College of Agriculture in 1927 was approximately 37 centavos.

2. Compared with the price of milk in other localities of the Philippines, our selling price of 42 centavos a liter may be considered cheap. However, even at such a low selling price, the College dairy herd, composed of relatively low producing cows, made a net profit of ₱330.90 in one year, or ₱12.25 each cow. Were the milk sold at ₱0.75 or ₱1.00 a liter the prices obtaining in Lipa, Batangas, and Manila, respectively, there would have been realized correspondingly higher net profits amounting to ₱2,720.99 in the former and ₱4,531.73 in the latter.

3. Should each kind of animal be used alone for producing milk, in one year ½ Indian buffalo–½ carabao cow might be expected to give a net profit of ₱84.06; the grade cow, ₱44.92; the Indian buffalo, ₱19.09; and the Nellore, ₱6.15. The carabao, on the other hand, would hardly pay for herself and the native and the Hereford cows would each cause a loss to the owner of about ₱49.14 and ₱47.08 respectively. This seems to indicate that the profit from the College dairy herd would have been much greater if the last three animals named had been excluded. If kept separately to produce one liter of milk, the cost would be 25 centavos for the ½ Indian buffalo–½ carabao; 27 centavos for the grade cattle; 36 centavos for the Indian buffalo; 39 centavos for the Nellore; 43 centavos for the carabaos; 71 centavos for the Hereford; and 89 centavos for the native cow.

4. Table 4 shows that at 42 centavos a liter of milk, disregarding the calf crop, in order to pay for the upkeep of the cow the carabao should yield, in one year, not less than 307.48 liters; Indian buffalo, not less than 322.95 liters; ½ Indian buffalo–½ carabao cows, not less than 312.67 liters; native cow, not less than 243.10 liters; Nellore cow, not less than 261.93 liters; Hereford cow, not less than 272 liters; and grade cow not less than 254.38 liters.

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TABLE 1

Animals in the milking herd and their production by group

ANIMALS	NO.	PRODUCTION	TOTAL PRODUCTION
		liters	*per cent*
Carabaos	5		
Iba, H. N. 1		1275.26	17.61
Bilog, H. N. 4			
Mabait, H. N. 9			
Tuntungin, H. N. 18			
College Beauty, H. N. 32			
Indian Buffalo	3		
Ana's Pride, H. N. 7		977.08	13.49
Indian Beauty, H. N. 11			
Miss Makiling, H. N. 10			
½ Indian buffalo—½ carabao grades	4		
Lady Una, H. N. 21		1981.04	27.35
Empress, H. N. 29			
Indipinas, H. N. 36			
Mabaits' Choice, H. N. 38			
Native Cattle	6		
Cleopatra, H. N. 51		619.78	8.56
Liberty, H. N. 54			
Estrella, H. N. 75			
Inasaran, H. N. 89			
Sampaga, H. N. 90			
Batangas, H. N. 76			
Nellores	2		
Felisa, H. N. 6		398.20	5.50
Jasmin, H. N. 30			
Hereford	1		
Minnie, H. N. 3		160.41	2.21
Grade Cattle	6		
Shine, H. N. 88		1830.14	25.27
Independence, H. N. 58			
Venus, H. N. 57			
Empress, H. N. 59			
Priscilla, H. N. 96			
Elisa, H. N. 78			
Total	27	7241.91	100.06

TABLE 2a

Net income realized in one year from the entire milking herd and the cost of producing one liter of milk

(Gross income)

SOURCES OF INCOME	QUANTITY	UNIT PRICE	VALUE	VALUE	GRASS INCOME
		pesos	*pesos*	*pesos*	*per cent*
1. Milk	7,241.91 liters			3,041.34	86.96
2. Calf Crop:					
(a) Carabao	432.14 kgm.	0.25	108.04		
(b) Indian buffalo	215.28 kgm.	0.25	53.82		
(c) ½ Indian buffalo–½ carabao	117.90 kgm.	0.25	29.48		
(d) Native cattle	229.85 kgm.	0.25	57.46		
(e) Nellore	260.28 kgm.	0.25	65.07		
(f) Hereford	——	—	——		
(g) Grade cattle	567.55 kgm.	0.25	141.88		

To produce 7,241.91 liters of milk cost............... ₱2,710.44

To produce one liter milk cost....................... 0.37

TABLE 2b

Net income realized in one year from the entire milking herd and the cost of producing one liter of milk

(Charges or costs)

ITEMS OF EXPENSE	QUANTITY	UNIT PRICE	VALUE	ITEM COST	CHARGES	TOTAL CHARGE
		pesos	*pesos*	*per cent*	*pesos*	*per cent*
1. Labor					1306.90	41.28
2. Feed					1100.04	34.74
a. Pasture (30 Ha. worth ₱15,000)			1032.00	93.81		32.59
Interest at 6%			900.00			
Tax at 88%			132.00			
b. Grain			63.53	5.78		
Corn	249.80 kg.	0.082	20.57			
Rice bran	704.50 kg.	0.052	36.44			
Copra meal	122.55 kg.	0.53	6.52			
c. Salt	141.00 kg.	0.32	4.51	.41		
3. Use of buildings					289.92	9.16
a. Dairy barn ₱2,000.00 } ₱2,406.00						
b. Milk room 406.00						
Interest at 6%			144.36			
Depreciation at 3.3%			79.40			
Tax at .5%			12.03			
Insurance at .25%			6.01			
Repairs at 2%			48.12			
4. Use of equipment					34.05	1.08
a. Bottles, milk ½ pint	1 gross		24.69			
b. Pails						
Aluminum	4	5.50	22.00			
Galvanized	5	1.25	6.25			
c. Cans						
Supply	1		10.00			
Laundry	1		18.00			
d. Stove, kerosene	1		40.00			
e. Pitchers, enamel	5	2.00	10.00			
Total cost of equipment			130.94			
Interest at 6%			7.86			
Depreciation at 20%			26.19			
5. Cow and bull cost					352.00	11.12
a. Cows	27	100.00	2700.00			
b. Bull	2	250.00	500.00			
Total cost of the whole herd			3200.00			
Interest at 6%			192.00			
Insurance at 5%			160.00			
6. Miscellaneous charges					83.28	2.63
a. Cotton, absorbent	24 rolls	1.07	25.68	30.83		
b. Caps, milk bottle	10,000	1.13 p.m.	11.30			
c. Kerosene	10 cans	2.15	21.50	25.62		
d. Soap, laundry	120 bars	.08	9.60			
e. Cloth, cheese	20 yds.	.26	5.00			
f. Vaseline, creoline, etc.			10.00			
Total gross charge					3166.19	100.01

TABLE 3

Cost for an average cow of each kind of animal to produce one liter of milk

	CARABAO	INDIAN BUFFALO	½ INDIAN BUFFALO ½ CARABAO	CATTLE			
				Native	Nellore	Hereford	Grade
	pesos	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*
Charges or costs							
Labor	48.40	48.40	48.40	48.40	48.40	48.40	48.40
Feed	49.74	54.67	51.39	29.26	35.25	38.61	32.85
Use of building	10.74	10.74	10.74	10.74	10.74	10.74	10.74
Use of equipment	1.26	1.26	1.26	1.26	1.26	1.26	1.26
Cow and bull cost	15.92	17.49	16.45	9.36	11.28	12.36	10.51
Miscellaneous charges	3.08	3.08	3.08	3.08	3.08	3.08	3.08
Total gross charges	129.14	135.64	131.32	102.10	110.01	114.45	106.84
Cost of production (Total gross charge minus the value of the calf crop)	107.53	117.70	123.95	92.52	77.47	114.45	83.19
Income							
1. From milk							
(a) Amount, liters	255.05	325.69	495.26	103.29	199.10	160.41	305.02
(b) Value, at 42 centavos per liter	107.12	136.79	208.01	43.38	83.62	67.37	128.11
2. From calf crop							
(a) Amount, kilos	86.43	71.76	29.48	38.31	130.14	None	94.59
(b) Value, at 25 centavos per kilo	21.61	17.94	7.37	9.58	32.54	——	23.65
Total gross income	128.73	154.73	215.38	52.96	116.16	67.37	151.76
Gain or loss	–0.41	19.09	84.06	–49.14	6.15	–47.08	44.92
Cost of producing one liter of milk	0.4216	0.3614	0.2502	0.895	0.3891	0.7134	0.272

TABLE 4

Minimum amount of milk each cow of the different kinds of animals should yield per annum in order to pay for herself under Los Baños conditions

	CARABAOS	INDIAN BUFFALO	½ INDIAN BUFFALO-½ CARABAO	CATTLE			
				Native	Nellore	Hereford	Grade
	pesos	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*
Total gross charge	129.14	135.64	131.32	102.10	110.01	114.15	106.34
Milk production, liters	307.48	322.95	312.67	243.10	261.93	272.50	254.38
Cost of producing one liter	0.42	0.42	0.42	0.42	0.42	0.42	0.42

A PRELIMINARY SURVEY OF RURAL SANITATION IN CALAMBA SUGAR ESTATE, CANLUBANG, LAGUNA PROVINCE[1]

ALBINO VIDAL

WITH SIX TEXT FIGURES

The Calamba Sugar Estate is one of the largest sugar estates in the Philippines. It has an area of about 6681 hectares. The five thousand laborers employed on the estate and their families live within its boundaries in Mill, Japanese, Lagundi, and Locomotive barrios and in Santa Rosa, Biñang, and Mañgumit sections. All inhabitants of these barrios and sections are subject to regulations laid down by the estate.

Object of the present survey

The objects of this survey were: To study (a) the general condition of the different barrios on the estate; (b) the disposal of sewage; (c) the disposal of garbage and waste, and (d) the water system.

Period of survey

The study covers a period of three months, from October, 1928, to January, 1929.

METHOD OF SURVEY

In this study, no effort was made to study chemical processes pertaining to sanitation. The study was from a layman's point of view.

The natural drainage of each barrio was studied, and the surroundings were inspected for (a) standing water, (b) empty cans, and whether there was water in them, (c) for the dumping place for waste and as to method of treatment.

The surroundings of each house in each barrio were inspected. The inside of the house was inspected for cleanliness and the kitchen utensils for care and convenience of arrangement.

After the inspection the occupants of each house were questioned as prescribed in a questionnaire.

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[1] Thesis presented for graduation, 1929, with the degree of Bachelor of Science in Agriculture from the College of Agriculture, No. 300, Experiment Station contribution No. 630. Prepared in the Department of Agricultural Engineering under the direction of Dr. Alexander Gordon.

Acknowledgment is due the officials of the estate, who made it possible for the writer to visit each barrio and section and to carry on the survey without any trouble or difficulty.

RESULTS AND DISCUSSION

Calamba Sugar Estate sanitary code

1. Occupants of houses will keep their premises clean and in a sanitary condition at all times. Weeds and grass must be kept cut short to the center of the street and half way between. If there be no street, then for a distance of six meters from the house.

2. All empty tins and refuse from kitchen must be carried to the place designated as garbage dump or placed in receptacle furnished for the purpose. Do not throw tin cans or rubbish in the tall grass or weeds near your house.

3. Do not keep pigs or chickens inside your house. They should be kept in pens or coops at least five meters from the house.

4. Do not make any alterations in your house unless authorized by the vice president or resident manager.

5. Do not allow strangers, friends or relatives to live in your house permanently without notifying the Police Department.

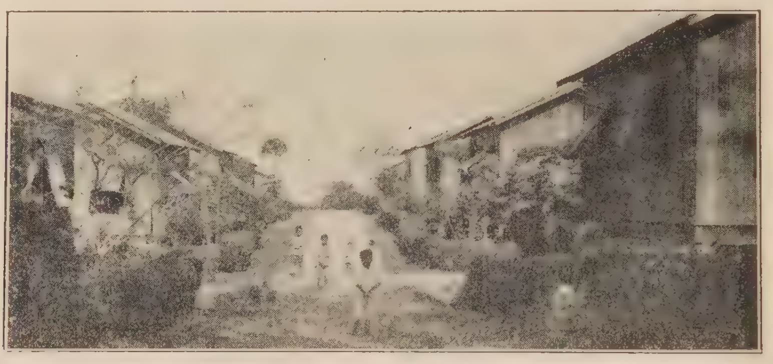

Fig. 1. Typical Street of Canlubang Barrio.
Note the cleanliness of street and orderly arrangement of the houses.

6. No firewood, structure of any kind, box or basket should be allowed to form contact between any portion of the building and the ground.

7 If 'anay' (white ants) appear in any of the lumber of the building you occupy mmediately destroy them and notify the Sanitary Inspector or Chief of Police. The same should be done in case any lumber is found to be decayed or broken, especially steps.

8. Great care should be exercised to keep the earth under and around buildings from washing away by heavy rains, and one good means of prevention is to grow and take care of a lawn around all sides of your house.

9. No dirt, papers, leaves or rubbish of any kind whatsoever should be allowed to enter drain canals. Said canals must be kept clean at all times.

10. Persons not complying with these regulations will be warned, fined, or removed to other quarters as the case may warrant.

11. Indications will be: good, fair, and bad. When the word 'fair' appears on your card, attention will be called to the condition of premises. Upon subsequent inspection, if the condition is not remedied, the word 'bad' will appear and a fine recommended.

The general sanitary condition

The Calamba Sugar Estate is a place where the importance of sanitation is fully recognized. The houses are arranged in rows. The surroundings of each house are kept clean by the occupants of the house. In Fig. 1 the condition of the hedges and ornamental plants around the house and also the cleanliness of the street may be noted.

The street is cleaned by the community. The occupants of one house clean one-half the street and those of the opposite house the other half.

No cans were found within a range of 10 to 15 meters from the houses. In some places small pieces of paper and the like were observed. This, however, would not necessarily affect the sanitary condition of the place because they were not breeding places of noxious insects. However, these made the yards look untidy.

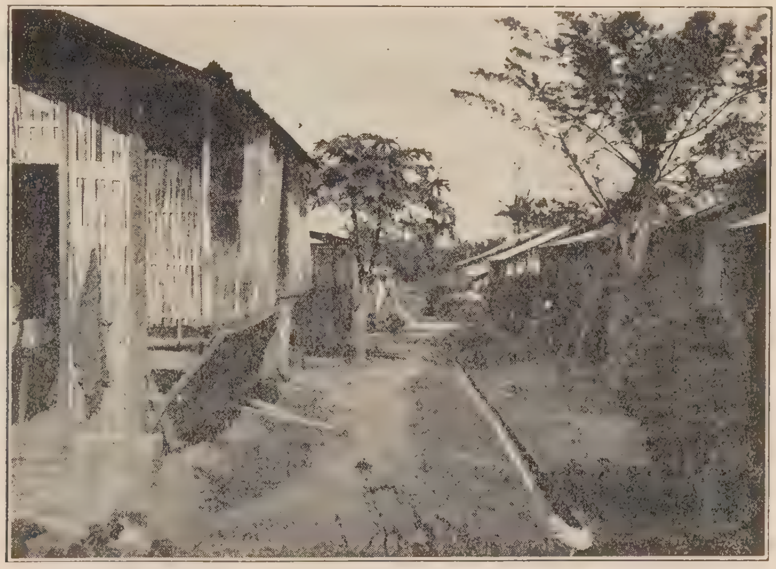

Fig. 2. Drainage Canal at Canlubang Barrio.
Note the construction of the drain which leads from the kitchen; also the waste receptacle near the door at the back.

Stagnant water was observed in Canlubang barrio at the end of the drainage canal, in the banana plantation, about 35 to 40 meters away from the nearest house. (See fig 2.) A foul odor was given off by the water, as there was decaying vegetation in it. Although this water was not near a house, it should have been treated with some sort of disinfectant, such as creoline or petroleum.

In the Santa Rosa section a similar condition was observed at the end of the drainage canal leading from the bath and wash room (see fig. 3). Here carabaos were seen drinking the stagnant water.

This pool of standing water was about one and a half meters wide and about three meters long. As figure 3 suggests, this pool was probably used as a drinking place by some of the farm animals.

Although each barrio on the estate is located in a place with natural drainage, ditches are constructed along the street to collect the water in one place whence it is diverted into the creek. These gutters are not only along the street but in the space between the kitchens of separate houses. (See fig. 1 and 2.) Because of this provision the yards and streets are quickly drained after a rain.

During the progress of this study no excrement of hogs or of other farm animals was found in or along the streets. The reason for this is that hogs are kept in hog pens about 20 to 25 meters from the houses.

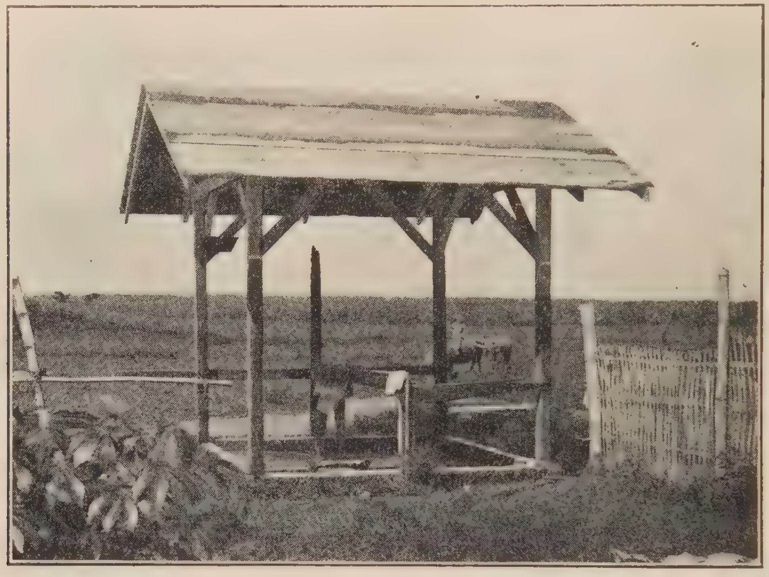

Fig. 3. **Bath and Wash Shed in Santa Rosa Section.**
Note the boy drinking from the faucet and the carabao drinking from the standing water.

Chickens are kept in pens about five to six meters from the house. Chicken excrement was found under some houses, which indicates that the fowls are allowed to brood under the house. Chicken coops and nests were found under some houses. This practice, however, is against the regulations. Carabaos and horses are kept away from the houses, consequently the streets and yards are not made foul.

The house and its surroundings

The houses in each barrio differ in materials, appearance, and construction, as may be seen in figures 1, 2, 4, and 5. In cleanliness, however, both in and out of the houses they are about the same. The only difference as to cleanliness of surroundings is that in Canlubang, Mill, Locomotive, and Japanese barrios no farm animals, as cows and carabaos, are kept so the sugar cane trash can not be used for feed, while in the Biñang and Santa Rosa sections carabaos and cows were kept behind the houses (see fig. 4). This was probably the reason that trash and manure were found there, making this part of the surroundings insanitary. If every morning this trash were burned and the manure scraped up and placed far from the house or in the near-by field, these two sections would not be behind Canlubang and Mill barrios in cleanliness.

The houses are about 5 meters apart, except those on a cross street. In figure 1 it is seen that the houses have two windows in front and one at each side, providing good ventilation.

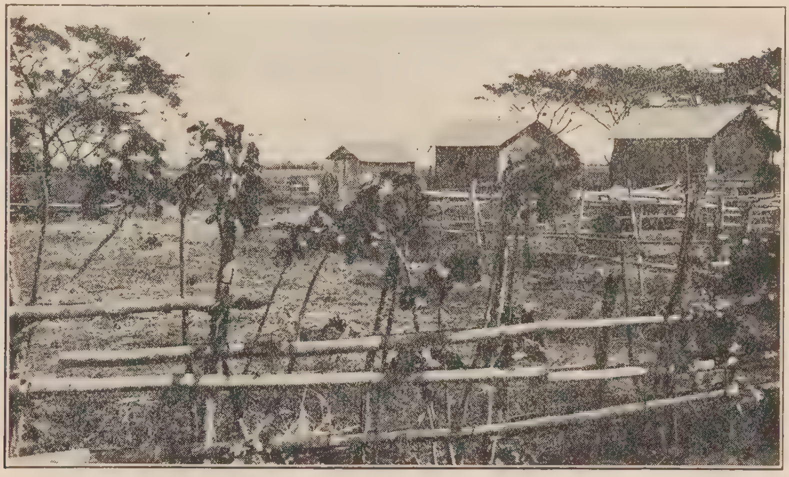

Fig. 4. Background of Houses in Santa Rosa Section.
Note trash and some farm animals in corral and also the arrangement of houses.

The floors are kept clean and polished by the use of petroleum or wax applied with rags and coconut husk.

The kitchens are kept clean and dry. It is quite easy to keep them so because of the drain leading from the kitchen to the main drainage ditch. The water that is used in cleaning in the kitchen flows into this drain (see fig. 2).

The kitchens are well ventilated. The side walls are made of bamboo woven slats. This affords free circulation of air. (Fig. 2.)

The disposal of sewage

The disposal of sewage is not the same in all the barrios. The mill and the clerks' quarters have the flush toilet system and the sewer line ends in a septic tank; while Mañgumit, Santa Rosa and Biñang sections and Canlubang barrio have another type, which is merely a pit dug in the ground with bamboo placed crosswise over the opening to form a platform for the user.

In Canlubang barrio the toilet is in combination with a bath and wash room. (See fig. 6.) The seats were found unclean owing to the carelessness of those who use them. The construction is good, because the water coming from the wash and bath room passes under the toilet, thus carrying the waste into the pit just back of the wash room. This pit is made of concrete with a sewer line leading into the creek. The sewer has vents which are to allow for cleansing in case the line becomes clogged or the water coming from the pit becomes sluggish.

If the people would report to the sanitary inspector any misuse of the toilet it would be a sanitary measure.

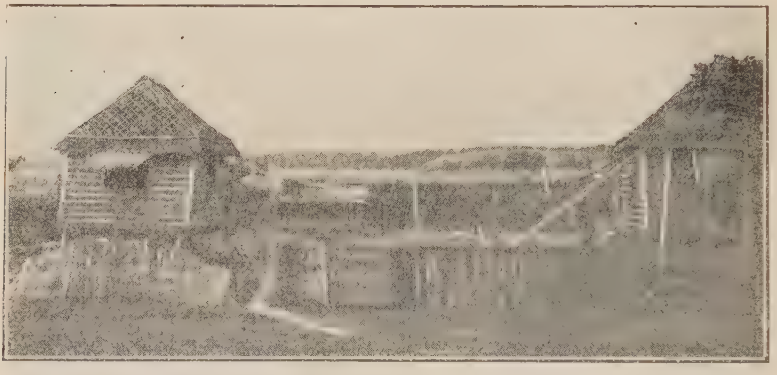

Fig. 5. Typical House in Biñang Section Hit by Typhoon of November, 1928.
Note the toilet in the background. This system is found in Santa Rosa section and in Mañgumit section.

In Santa Rosa, Mañgumit, and Biñang sections the Antipolo system is used. All are treated with creoline and lime.

In Canlubang the toilet is built about 15 to 20 meters away from the nearest house; in Santa Rosa about 35 to 40 meters; and in Biñang about 10 to 15 meters.

Disposal of garbage and waste

Each house has garbage and waste containers. The majority of receptacles used are empty petroleum cans. Some use pots, basins and small cans. These garbage receptacles are placed in the kitchen near the place where the dishes and cooking utensils are washed. This makes it convenient when washing the dishes to throw any kitchen refuse suitable for pigs or chickens into the garbage can. The water is thrown into the drainage canal. (See fig. 2.)

Occupants of some of the houses who have such garbage receptacles have no pigs to feed, so they use pots, basins, and small cans for garbage and give the contents to their neighbors who own pigs.

In almost all garbage receptacles that were inspected the contents were found to be cooked rice, scrapings of dishes and pots, banana peelings, and vegetable leaves.

No receptacle was found covered, but as the odor of the garbage attracts the flies, such cans should be covered.

Each house is provided with a waste receptacle. In this is put the waste collected from the yard and kitchen refuse not fit for hogs, chickens, or dogs.

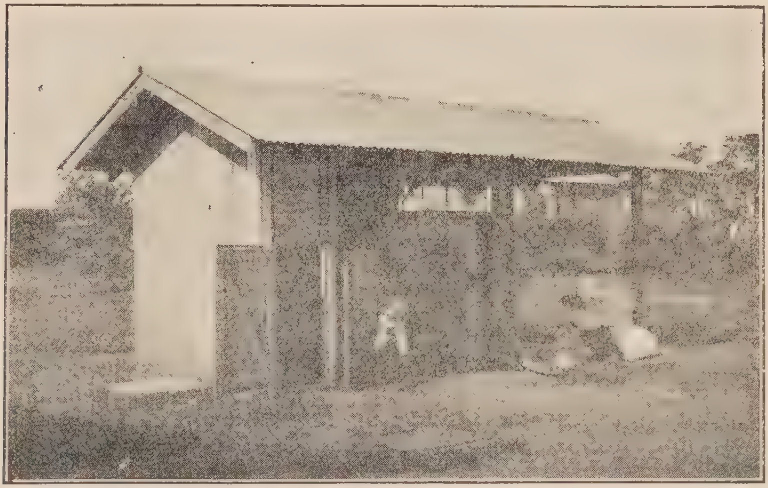

Fig. 6. Wash, Bath and Toilet Combined in One House. Note the faucet near the washing portion, from which the water for home use is taken. The open door leads to the toilet room.

According to the occupants of each house, when the can is full it is carried to the dumping place and emptied.

Dumping place

The barrios are provided with dumping places. According to the chief of police, who is in charge of the enforcement of the sanitary regulations, the waste in the dumping places is burned when there is enough and it is dry.

Water system

Calamba Sugar Estate is traversed by a creek. The water is not used by the community, therefore the danger of drinking polluted water is quite remote.

The estate provides each barrio with a deep well. The water from this well is pumped by an engine. Connected with the tank is a pipe leading into the barrio, where it has branches and is connected with each toilet, bath, and wash room which are combined under one shed. (See fig. 6.) Near the wash room is a faucet where the people of the community get their water for home use.

The distance of the well from the toilet is about 50 meters at Santa Rosa, 100 meters at Biñang, 200 to 250 at Canlubang barrio. It is, therefore, safe from seepage water from the toilet.

The market

It is the regulation, according to the man in charge of cleaning, that the market shall close at eleven.

Vegetables, fish, and other products are sold in the market on stalls on the floor.

If the sellers, or tenderas, were obliged to bring to the market ordinary tables for the wares they sell, the market would look better and be more sanitary. Also if these sellers were arranged so that those selling vegetables were in one place, sellers of meat in another, fish in another, and so on, much time of the buyers would be saved and the food stuff for sale would be in better condition.

The market is clean. There is a man in charge of cleaning it.

Near the market is a closet of the type found in Canlubang barrio. There is a wash and bath room combined with the closet.

Common illnesses on the estate and the control

Malaria. Malaria cases were noted in Biñang section, which is very far from the main center of the estate. Very few cases from the estate had been treated in the estate hospital, according to Doctor Yatco, the physician in charge.

Dysentery. Dysentery, a disease usually contracted from water and foods, is not a problem in the Calamba Sugar Estate, as very few cases have been reported.

SUMMARY AND CONCLUSION

Calamba Sugar Estate provides all the necessary facilities for the laborers to guard their health. It provides hospital service for its employees and laborers. The estate enforces regulations pertaining to sanitation so that they may have a clean and safe place in which to live.

The sanitary code is a model of concise and forceful regulations.

THE WORKING OF SOME RURAL CO-OPERATIVE CREDIT ASSOCIATIONS IN CAGAYAN AND ISABELA[1]

PABLO N. MABBUN
Of the Department of Rural Economics

One of the most important problems in the Philippines to-day is to provide capital for the development of our farms and for transportation of products to market. The Bureau of Commerce and Industry estimates the area of all farms in the Philippines in 1918 at 4,563,723 hectares. Only 2,415,778 hectares, or 59.9 per cent, of this area is now cultivated, while the rest, 2,147,945 hectares, or 47.1 per cent, remains idle. The abandonment of these farms already owned is due largely to lack of capital of the owners. We also hear of cases where our farmers are forced to sell their produce at great loss because they have to give it to their unscrupulous creditors who exact from them exorbitant rates of interest for money, borrowed long before their crops are harvested.

The Philippine Government has long ago realized this need of our agriculturists. In an effort to encourage early solution of this problem, the Philippine Legislature passed Act No. 2508, commonly known as the Rural Credit Law, which provides for the creation and operation of rural co-operative credit societies throughout the Archipelago. As a result of this encouragement, Prautch (1929) reports 547 municipalities throughout the country with rural co-operative credit associations. These associations have a total membership of over 80,000 which has paid in over ₱900,000 for shares. The Government has the ₱1,000,000 rice and corn fund from which loans are made to associations which can furnish the required security. Associations which borrow from this rice and corn fund in turn loan the money to their members. The total capital of the entire Rural Co-operative Credit System which is actually loaned out to members is over ₱2,500,000. The loans are mostly from ₱50 to ₱200, according to Prautch.

This study was conducted in three of the largest municipalities in the Cagayan Valley, from May 14 to June 6, 1928. There was no formal questionnaire prepared for this piece of investigation. The writer approached the municipal treasurer of each municipality, presented his letter of introduction from the Dean of the College of Agriculture, and then requested him to show the books in which records of the transactions and other matters relative to the business of the co-operative credit association were kept. The writer also interviewed the presidents of the boards of directors of the associations, some of the members and other persons who had any knowledge of the existence of such associations in the three municipalities.

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[1] Experiment Station Contribution No. 629.

The purpose of this study was to get first-hand information about the working of some of the rural co-operative credit associations for the purpose of giving such information to students of economics in the College of Agriculture, University of the Philippines, and to suggest improvements in the operation of such associations if any flaws were discovered.

METHOD OF ORGANIZATION

The rural co-operative credit associations in the Philippine Islands were all organized under Act No. 2508, known as the Rural Credit Law. They are of the type of co-operative associations established with capital stock for pecuniary profit. There is, therefore, no difference in the procedure followed in the organization of the individual associations, which is described as follows:

A number of interested persons gather together to discuss the object and advantages of establishing a co-operative credit association. When they have decided to form an association, each buys shares at ₱2 each. They pay for these shares to the municipal treasurer of the town, who issues official receipts which will be exchanged later for share certificates after the organization has been incorporated. Each member may buy as many shares as he wishes, up to ₱500 worth. Those who have bought shares elect their officers. Now, as soon as ₱250 cash from sales of shares has been paid in, the members can incorporate for ₱5,000, the minimum capital stock allowed these associations by law. Each member also pays 50 centavos as entrance fee for incidental expenses of the association.

The only officers of the association are the members of the board of directors. This is composed of a president, secretary, treasurer, and two directors. These officers are elected by the members. The municipal treasurer is the ex-officio treasurer of the association. He serves without additional compensation. The other members of the board of directors may or may not receive any compensation. In most associations, they serve without compensation. In some cases, however, Arnaldo (1929) reports that they receive a certain percentage of the profits of the associations.

After incorporation, the association urges each member and outsiders to deposit money with the association, as in a savings bank. The association pays six per cent per annum interest on deposits. This money may be loaned out to members at a higher rate of interest.

Table 1 shows the number of members of each of the associations studied and the amounts received from sale of shares.

Table 1 shows that the "A" association sold ₱1,210 in shares to 71 members; the "B" association, ₱550 to 40 members; and the "C" association, ₱2,124 to 177 members. The population of these municipalities, according to the Census of 1918, is 20,604; 19,298; and 23,279, respectively. Considering the population of these three which are the largest municipalities in the Cagayan Valley, and the fact that they are principally agricultural communities, these figures show that the rural co-operative credit movement is far from being popular in these towns. These associations were established between 1917 and 1919, and up to June, 1928, their membership had reached only these proportions.

No member in any of the three associations bought shares amounting to ₱500. The largest individual investment is ₱300, which represents the price of 150 shares in the "A" association. The smallest amount any one member invested is ₱2, or one share.

Procedure for incorporation

The provisions of the Corporation Law, Act No. 1459, governing all corporations also applies to the rural co-operative credit associations as far as preparations of the incorporation papers are concerned. The following items should be included in the incorporation papers of a rural co-operative credit association:

1. Name of the association
2. Number of members
3. Purpose
4. Officers
5. Managers
6. Total expense to be incurred
7. Total ultimate capital
8. Place of business
9. Real property on hand
10. Trade mark or brand, if any

With the incorporation papers a fee of from ₱10 to ₱25, depending upon the size of the association, is required. Corporations and associations are incorporated with the Bureau of Commerce and Industry.

MEMBERSHIP

The three associations studied have a total membership of 294. This number includes different classes of people, physicians, pharmacists, farmers, laborers, and others. This fact is also true of many of the rural co-operative credit associations in other provinces. This is because the Rural Credit Law provides that any person may become a member of a rural co-operative credit association in the town where he resides.

It is very difficult, if not impossible, for people of conflicting economic interests to get on together smoothly. The writer found that this is true of the members of the associations studied. Some of the members are indifferent to the failure or success of their association. A few even used their association to further their own interests. The more intelligent members have taken advantage of the ignorance of the others and borrowed large amounts of the investments, which were unpaid up to 1928.

Powell (1919) and other students of co-operative associations are unanimous in the belief that one of the fundamental principles upon which the success of any such association is built is that it should be composed of persons having the same interests, persons on the same economic level. Again, it is said that it should be born of necessity, that is, the members should be the ones who feel the need for an association and that its organization should come from their own initiative. The writer found that each of the three associations was started by people in the heart of the municipalities who have no need of credit. It is, therefore, natural that after the associations were organized and incorporated the members invariably lost interest. Thus, we see that few persons in these largest three towns in the Cagayan Valley joined the rural credit associations during the years of their existence.

LOANS

The Rural Credit Law provides three kinds of securities that may be offered by members of the associations for loans. These are: (1) personal security which consists of a bond signed by two or more persons of recognized solvency in the municipality concerned; (2) pignorative security which consists either in pledging stock in the association; by pledging to the association of standing harvested, gathered, or stored crops, or machinery and implements used in agricultural operations, or livestock and any other property susceptible of being separated without deterioration of the land to which it is attached; the loan not to exceed in any case fifty per cent of the value of such property; and (3) mortgage upon unencumbered real estate; but the loan in no case to exceed fifty per cent of the market value of such real estate in the case of unregistered titles, and sixty per cent in the case of registered titles.

Only mortgaged loans were granted to members of the three associations under consideration. In other words, only number 3 security mentioned above has been acceptable to these associations.

"A" Association

Table 2 shows that "A" association loaned a total of ₱2,950 to 28 of its 71 members. This means that only 39.43 per cent of the entire membership has made use of the association funds since its organization in 1917. Records show that most of the loans have not yet been repaid.

Some loans were due as early as 1919, but in June, 1928, when this study was made, they had not yet been refunded. The treasurer of the association told the writer, however, that the debtors have always paid the interest on their loans.

Although the majority of the loans of this association are long overdue yet nothing has been done by the board of directors to induce the debtors to pay. The members of the board do not take much interest in the welfare of their association. The president told the writer that it was difficult to secure a quorum in order to conduct a meeting, and that many of the loans were granted by the treasurer and himself only, inasmuch as he could not have a meeting of the board when there were applications for loans awaiting its approval.

"B" Association

Table 3 shows the list of loans to members of the "B" association.

This association loaned ₱1,725 to 9 of its 46 members. This means that only 19.57 per cent of the total membership has made use of the association funds since its organization in 1919. Three of the nine debtors owing a total of ₱700 are members of the board of directors. As in "A," the loans of the "B" association have not yet been settled. In addition to the principal, there was still, on December 31, 1927, ₱395 due in interest.

The president told the writer that they had not done anything toward collecting overdue loans, because they had not yet been able to hold a meeting, owing to the indifference of the directors. "There are times," he said, "when I have to act alone in approving applications for loans. I have had to do this because I could not get a quorum of the directors."

The writer, however, found that the members did not like to come to a meeting because some of them are debtors to the association. The president himself is indebted to the association to the extent of ₱300. Two other directors are borrowers also. These directors, including the president, compose the majority of the members of the board. The president could not get a quorum when a meeting was needed because he himself did not wish it to be held. He is indebted, and if the purposes of the meeting were to talk about the collection of overdue loans, then these directors would be criticized. That was the real reason why they have never had a meeting since 1925, when the president's debt became due.

"C" Association

The "C" association loaned ₱4,496 to 79 of its 177 members. This shows that 44.63 per cent of the total membership has been enjoying the advantages of membership in the association since its organization in 1917. Table 4 shows the loans to members of this association.

Apparently, this association has fulfilled one of the purposes for which it was established—to serve its members by according them loans in small amounts so that a greater number could take advantage of its existence. But it has failed, as in the case of the other two associations, in collecting its loans. This is due to the laxity of the members of the board of directors in dealing with delinquent debtors.

How a loan is obtained

The member who wishes to obtain a loan from the association makes a written application stating the amount desired. He accompanies this application with the title of his land and a statement declaring that it is not encumbered. The board of directors determines the market value of the land, the title of which is presented as security. If they approve the application, the loan is granted. If the board finds that the market value of the land is not at least twice the amount applied for as loan, they advise the applicant or recommend a loan that will equal at most fifty per cent of the value of the land. The applicant gets the money from the municipal treasurer who keeps the land title as surety and enters the name of the borrower and the amount of the loan in his book. The duration of the loan is one year, but it can be renewed every year for five years upon request.

The Rural Credit Law specifies that application for loans should be passed by the board of directors of the association concerned before any money can be released by the treasurer. It was found, however, that there were a few cases when the president and the treasurer alone granted loans to members of the associations.

How a loan is repaid

A loan from the rural co-operative credit associations can be repaid either in full or by installments. These associations allowed monthly installment payments on loans even as small as ₱10 . One particular instance is the loan to the president of the "B" association amounting to ₱300 which he is paying by installments of ₱40 a month. There are other cases in the three associations where long overdue loans are being paid in installments of ₱10 a month.

DIVIDENDS

This study shows that these three associations have not paid any dividends to their members since they were established. This is because most of their loans have not yet been repaid. Moreover, these associations are not engaged in any other business than loaning money to their members and receiving deposits from members and outsiders. Hence, the interest received on the overdue loans has not been enough to warrant the issuance of dividend.

DEPOSITS

One of the purposes of the rural co-operative credit associations in the Philippine Islands is to encourage thrift among the people by allowing anybody to deposit money with them and paying six per cent interest on such deposits. Deposits as small as ₱3.75 may be received. Prautch says in a circular letter issued July 1, 1919, "There are only five denominations: ₱3.75 which returns ₱5; ₱7.50 which returns ₱10; ₱15 which returns ₱20; ₱37.50 which returns ₱50, and ₱75 which returns ₱100 at the end of five years. . ." Prautch referred to cash deposit certificates issued to depositors with the rural co-operative credit associations.

Any person, member or outsider, who wishes to deposit any amount with the rural co-operative credit associations hands his money to the municipal treasurer of the municipality where he makes the deposit and gets an official receipt for the amount. This receipt is sent to the Director of the Bureau of Agriculture, Manila, who will issue cash deposit certificate covering the amount in exchange for the official receipt of the depositor.

The study shows that there were six depositors in the three rural co-operative credit associations studied, two depositors in each association. Table 5 shows the number of depositors and the amounts deposited by each.

The result of the activities of the three associations in this direction shows that they failed to educate or induce the people of the three municipalities to invest. This may be due to the ignorance of the people about the real purpose of the rural co-operative credit associations. The writer observed that there are many people, especially farmers, in these municipalities who do not even know about the existence of the rural credit associations. This is true in the case of many of the farmers in the towns where the "A" and "B" associations are located. When the writer approached some of the farmers and asked them if they knew that they could borrow money at a very low interest if they were members of the rural co-operative credit association in the town, these farmers expressed surprise. Why are these farmers not informed of the existence of the rural co-operative credit associations?

The reason for this ignorance is because these associations are established in the heart of the towns. Moreover, those who started the associations were people who do not farm, hence they are not interested in promoting the welfare of the farmers. Those who live far away from the center of the municipalities and seldom go to town do not learn of the existence and purpose of the associations.

HOW THE ASSOCIATIONS ARE SUPERVISED

Each of the associations is incorporated and has all the corporate powers granted other incorporated organizations. According to law the Director of the Bureau of Agriculture is the technical and legal adviser of these associations. Prautch (1929) says:

> The law states that in case any association violates the law or by-laws he (the Director of Agriculture) shall give the necessary orders to the board of directors to have the defects remedied and in case of noncompliance he shall request the secretary to call a meeting of the stockholders in order to determine whether there are grounds for the removal from office of the responsible director or directors. In a word, we stand by with hat in hand and tears in our voices pleading for the crooked directors to please stop grafting. . . .

Three associations are under the supervision of a rural credit agent of the Bureau of Agriculture. The work of this agent consists in going from one municipality to another and taking note of what the association in each town is doing. If he finds any faults in any association, he warns the members of the board of directors and suggests that the defects be corrected. If he finds any mistakes in the books of the treasurer, he warns the latter to make the necessary corrections, and, if the treasurer does not heed his suggestions, he reports the matter to the district auditor who has the final word about the books of the associations in all the municipalities under his jurisdiction. The agent does not have any voice whatsoever in forcing the members of the board of directors to do anything toward the collection of debts. He cannot even call a meeting of the board if the members do not wish to meet. All he can do is to tell them, "Please do this and do that," in a very polite manner, otherwise he might find himself ignored.

AUDITING

The books of the rural co-operative credit associations are audited by the government auditors in connection with the books of the municipal treasurers. They do this without extra compensation.

SUMMARY

The rural co-operative credit associations in 547 municipalities throughout the Philippine Islands have been organized under Act No. 2508, known as the Rural Credit Law. This law was passed by the Philippine Legislature in 1916. These associations were established mainly to supply the needy farmers with capital for the operation and improvement of their land. to prevent their borrowing money from usurers and to educate these people in the value of thrift and saving. These associations have a total membership of over 80,000 and a total capital of over ₱2,500,000 all actually loaned to members. The results of the study on the work of three associations in the Cagayan Valley may be summarized as follows:

1. The three associations sold ₱3,884 in shares to 294 members since their establishment in 1917. This is distributed as follows: The "A" association sold ₱1,120 in shares to 71 members; the "B" association, ₱550 to 46 members; and the "C" association, ₱2,124 to 177 members. The municipalities where the associations are located are the largest towns in the Cagayan Valley. These towns are principally agricultural communities. The small number of members of the association in each of these towns indicates that the people are not well informed about the working of the association.

2. The three associations have admitted all kinds of people including Physicians, pharmacists, laborers, and farmers as members. This is contrary to fundamental principles upon which the success of co-operative associations depends. In order to be successful, it should be composed of per-

sons who really feel the need for co-operation, who have similar interests, and who are practically on the same economic level. Because the members of these associations have conflicting interests, it has been discovered that the more intelligent ones, the pharmacists and the physicians, for example, have been the ones who obtained large loans or used the association's funds to further their own interests, whereas the farmer members were the ones who could get the smallest loans.

3. Much more than half of the loans have long been overdue, some of them having matured in 1919, but nothing has been done by the board of directors to force the delinquent debtors to refund their loans. This is because in some cases it was found that some of the members of the board of directors are themselves delinquent borrowers.

4. These associations have not declared any dividends since their organization. This is because they have no profits and have no other business enterprise than loaning money to members and receiving deposits. Moreover, most of their loans have not yet been paid, and the interest received does not warrant any attempt to distribute dividends.

5. There are only two depositors in each of the three associations showing a lack of appreciation by the inhabitants of the work of the rural credit associations.

6. Inasmuch as these associations, were started by people who really have no need of credit, as soon as the associations were established and incorporated, they were left to themselves. This indifference on the part of the organizers accounts for the little accomplishment they have made in the period of over eleven years since their establishment.

PRAUTCH, A. W. 1929. Our rural credit associations. Commerce and Industry Journal 5: 6.

ARNALDO, M. V. 1929. Here and there among the rural credit associations in Panay Island. (Unpublished.)

POWELL, HAROLD G. 1919. Co-operation in agriculture. 327 p. New York: Macmillan and Company.

TABLE 1

Receipts of the three associations from sale of shares and number of members in each

NAME OF ASSOCIATION	NUMBER OF MEMBERS	VALUE OF SHARES	POPULATION OF EACH TOWN IN 1918
		pesos	
“A”..........	71	1,210	20,603
“B”..........	46	550	19,298
“C”..........	177	2,124	23,279
Total.....	294	3,884	63,180

TABLE 2

Loans to members of the “A” association

DEBTOR NUMBER	BALANCE UNPAID	DATE OF MATURITY	REMARKS
	pesos		
1	500	4– III–’19	Interest paid up to 1925
2	100	15– IV–’20	Interest all paid
3	20	29– VI–’23	“ “
4	50	29– VI–’23	“ “
5	100	1– VII–’23	“ “
6	100	1– VII–’23	“ “
7	100	30– VI–’23	“ “
8	100	1– VII–’23	“ “
9	100	20– VII–’23	“ “
10	100	20– VII–’23	“ “
11	100	20– VII–’23	“ “
12	100	20– VII–’23	“ “
13	100	20– VII–’23	Paid in full May 12, 1927
14	100	20– VII–’23	Interest all paid
15	30	20– VII–’23	“ “
16	100	25– VII–’23	“ “
17	100	19– VII–’23	“ “
18	100	21– VII–’23	Pain in full June 10, 1927
19	100	9–VIII–’23	Interest all paid
20	100	18– VI–’24	“ “
21	100	25– IX–’24	“ “
22	100	29– IX–’26	“ “
23	100	3– XII–’26	“ “
24	100	25–VIII–’28	Not yet due
25	100	25–VIII–’28	“ “
26	100	25–VIII–’28	“ “
27	100	29– IX–’28	“ “
28	100	23– XI–’28	“ “
Total...	2,950		

TABLE 3

Loans to the members of the "B" association

DEBTOR NUMBER	BALANCE DUE	INTEREST UNPAID	DATE OF MATURITY
	pesos	*pesos*	
1	200	100	17–II–'21
2	425	—	19–IV–'21
3	50	40	11–VI–'22
4	200	20	23–II–'22
5	70	15	3–III–'22
6	200	20	12–III–'22
7	180	40	14–III–'22
8	100	40	22–III–'22
9	300	120	1–III–'23
Total. .	1,725	395	

TABLE 4

Loans granted to members of the "C" association

DEBTOR NUMBER	BALANCE DUE	DATE OF MATURITY
	pesos	
1	100	21– X–'19
2	50	29– X–'19
3	50	4– XII–'19
4	50	5– XII–'19
5	50	17– XII–'19
6	50	16– II–'20
7	50	29– XII–'20
8	25	23– II–'20
9	50	28– IV–'20
10	50	5– V–'21
11	50	5– V–'21
12	50	5– V–'21
13	35	6– VIII–'21
14	50	19– I–'22
15	50	5– XII–'21
16	50	8– II–'22
17	50	26– XI–'22
18	50	20– III–'22
19	50	2– I–'22
20	50	12– II–'22
21	50	19– I–'22
22	50	17– II–'22
23	50	21– II–'22
24	50	5– III–'22
25	40	5– VII–'22
26	50	6– II–'22
27	100	26– XI–'22
28	28	31– III–'22
29	100	31– XII–'22
30	50	29– VI–'22
31	50	10– II–'22
32	50	1– II–'23
33	50	25– III–'23
34	50	11– III–'23
35	40	24– III–'23
36	50	23– XII–'23
37	100	2– I–'23
38	100	2– I–'23
39	100	8– VII–'23
40	33	21– VIII–'23

(Carried forward)

TABLE 4—continued

41	100	2–XII–'23
42	50	28– I–'24
43	50	12– III–'24
44	50	18– V–'24
45	50	19– III–'24
46	50	10– III–'24
47	50	16– II–'24
48	50	29– III–'24
49	50	26– X–'24
50	50	10–XII–'24
51	50	28– V–'24
52	50	5– V–'24
53	50	5– V–'24
54	36	26– VI–'24
55	50	13– III–'24
56	50	5– XI–'24
57	50	16–VII–'26
58	100	16–VII–'26
59	100	16–VII–'26
60	50	20– X–'26
61	29	29– VI–'26
62	50	24– III–'26
63	50	24– III–'26
64	50	17–XII–'25
65	50	11– IV–'25
66	50	2– III–'26
67	50	11– IV–'26
68	100	31– III–'27
69	50	19–XII–'25
70	50	28– IV–'27
71	50	17– II–'28
72	100	18– II–'28
73	50	27– X–'27
74	100	27– IV–'28
75	100	17– V–'28
76	50	11– VI–'28
77	50	10– II–'28
78	100	10– II–'28
79	30	5– VI–'28
Total. . .	4,496	

TABLE 5

Deposits with each of the three rural co-operative credit associations

DEPOSITOR NUMBER	DEPOSIT
"A" ASSOCIATION	
	pesos
1	50.00
2	75.00
Total..........	125.00
"B" ASSOCIATION	
1	100.00
2	100.00
Total........	200.00
"C" ASSOCIATION	
1	181.36
2	200.00
Total..........	381.36
Grand total.....	706.36

COLLEGE AND ALUMNI NOTES

The enrollment of students of the College of Agriculture for the second semester, 1929-1930, dropped to 692; the total for the first semester was 750. The reduction was due to rigid application of scholarship rules, which automatically culled out students of poor standing in scholarship.

At a recent meeting of the University Council, it was approved to recommend the graduation of the following seniors who have satisfied all the requirements leading to their respective degrees:

Bachelor of Agriculture—Magdaleno Caguicla, Joe R. Haynes, Emilio Kraft, and Victorio Olan.

Bachelor of Science in Agriculture—Buenaventura M. Aguanta, Conrado T. Reyes, Toribio Mercado (B. Agr., 1926), and Fernando Reyes (B. Agr., 1925).

Bachelor of Science in Sugar Technology—Agustin L. Hermano, Ernesto Jamora, Agustin R. de Luzuriaga, and Manuel Villano (cum laude).

Dr. Vicente G. Lava, associate professor of agricultural chemistry, has been granted a year's leave in order to accept a research fellowship in colloid chemistry in Oberlin College, Ohio. He sailed for the United States on October 4.

Representative José G. Sanvictores, of Bukidnon, was a recent visitor of the College, where he conferred with Dean Gonzalez and inspected the work of the Department of Animal Husbandry. Mr. Sanvictores is manager of a large cattle ranch in Bukidnon.

Professors L. B. Uichanco, G. O. Ocfemia, and R. B. Espino attended the coconut planters' conference in San Pablo, Laguna, on November 4, on the invitation of Provincial Governor Dizon, in order to discuss the present situation of the leaf miner, *Promecotheca cumingi* Baly, which threatens the coconut industry in that municipality.

Dr. R. L. Pendleton, professor of soil technology, went on accrued leave beginning the latter part of November in order to work on a soil survey of the La Carlota District, Negros Occidental, and later to visit his home in California. Professor I. Elayda is teaching Doctor Pendleton's classes temporarily.

Mr. Angel Africa, '20, formerly assistant in physics in this College, is now chief chemist of the Philippine Cutch Corporation at Balioasan, Mindanao.

Mr. Vicente B. Aragon, '18, formerly farm manager of the Central Luzon Agricultural School at Muñoz, has been recently appointed instructor in agronomy at this College.

At a recent meeting of the Board of Regents, Dr. F. M. Fronda was appointed secretary of the College and Dr. F. O. Santos, head of the Department of Agricultural Chemistry in a permanent capacity.

Mr. Atanacio Hizon, '28, formerly assistant in agricultural chemistry at this College, resigned in order to accept a position as planters' chemist of the Central Azucarera de Tarlac.

The resignation of Mr. Fernando Reyes, assistant in agronomy, has recently been accepted by the Board of Regents.

Mr. Moises M. Kalaw has been transferred from the Extension Division to the Department of Agronomy, where he is now an assistant.

Mr. Otto Wyss, of the agricultural department, Warner, Barnes & Co., Ltd., Manila, recently came to the College in order to secure data on the growing of peanuts, a crop in which his firm is becoming actively interested.

The following papers were read and discussed in the past three meetings of the Los Baños Biological Club:

Forty-seventh meeting, September 19, 1929

1. Chemical studies on coconut products. Dr. Vicente G. Lava.
2. The textile industry in the Ilocos provinces. Mr. Eulalio P. Baltazar.

Forty-eighth meeting, October 31, 1929

1. The presence in human feces of the ova of fish trematodes. Drs. M. A. Tubangui and S. A. Francisco.
2. Base exchange and soil characteristics in relation to soil growth. Prof. R. H. King.

Forty-ninth meeting, November 21, 1929

1. Ramai rice variety and its culture in Central Luzon Agricultural School. Mr. Vicente B. Aragon.
2. Determination of red and white blood corpuscles and hemoglobin in Filipino ponies (preliminary report). Dr. Ramon Q. Javier.
3. An illustrated guide to the collections of economic and ornamental plants in the College of Agriculture. Dr. N. B. Mendiola.

Indicative of the extension of activities of the Department of Military Science and tactics is the addition to its curriculum of a course in artillery. Four 75-mm field pieces, complete with all the necessary tools, have been recently received for use in training the cadets in handling big guns. Cadet Captain Cornelio Mariano, who has recently been promoted from first lieutenant, is in command of the artillery battery. The other officers are Cadet First Lieutenants Elias Posa and José C. Gaton and Cadet Second Lieutenants Rene G. Prado and Agustin Castro. The cadets have elected Miss Maria Mulingbayan battery sponsor.

Recent promotions among the cadet officers were as follows: *From cadet second lieutenants to cadet first lieutenants*—Honorio Samonte and Cosme Reynes. *From cadets to second lieutenants*—Nicanor Bartolome, Francisco Franada, José P. Biboso, and Crecenciano Causing.

BRINGING THE MOUNTAIN TO MOHAMMED

Provincialism in any phase of human activity carries along with it undesirable connotations; such an attitude of mind in scientific work is bound to produce impossible situations and even disastrous results. It has been repeatedly stated that science recognizes no political boundary and that no country can afford to ignore what is being accomplished along scientific lines in other parts of the world without running the risk of falling into a rut and in this way hampering its own material and cultural progress.

The remote position of the Philippines from recognized centers of learning and the regrettable lack of opportunity for foreign travel of Filipino scientists have always worked to their disadvantage and that of others who have chosen to make the Philippines their more or less permanent field of service. The first difficulty is, of course, irremediable. As to the second, it would be a tiresome rehearsal of an old, overworked theme to dwell on the obvious necessity of giving our scientific workers greater facilities for travel in order to broaden their intellectual horizon and, above all, to establish more intimate contacts with fellow workers along their special lines. For many years now certain countries have been consistently carrying on a program of periodic sojourn abroad for their technical men. To cite only two examples: Japan has gone one step ahead in this direction; after every four years of duty, a Japanese scientist in the employ of his Government is required—not merely privileged—to spend one year of sabbatical leave elsewhere. Public funds are liberally provided for this purpose. Java, we understand, resorts to a similar general practice. The remarkable progress in agricultural and other sciences attained by these two of our neighboring countries, with their efficiently organized laboratories producing at rapid pace original contributions of lasting value, may in a large measure be attributed to this farsighted policy.

Until some such plan can be carried into effect on an assured and more permanent basis in the Philippines, the capacity for useful service of our scientific personnel will remain perilously below the optimum, and our scientific standards be steadily undermined by the devitalizing effects of this forced seclusion. Fortunately for us, this persistent menace is given a temporary set-back from time to time by visits of foreign scientists to our institutions. But this source of relief is most undependable. We get these welcome visitors only by chance, when the Philippines happen to lie in their path and they cannot help but take this country in as a side trip; when searching for natural enemies of noxious insects for introduction into their homelands; when certain plant, animal, or human diseases can be most favorably studied here; or when any part of our Islands furnishes a strategic position for observing a total eclipse of the sun. The benefit that accrues to local scientific organizations and personnel from such occasional, although often brief, contacts is patent and beyond dispute. Likewise, those fortunate few in the Philippines who have a chance to be sent as delegates to international scientific congresses abroad, the selected few University professors who succeed in securing authority for a sabbatical leave, and some of the more promising younger men and women who are appointed as fellows or pensionados in American and European universities supply fresh stimulus to our scientific life with new ideas and information which they bring with them upon their return.

An encouraging sign of the times has been the program recently inaugurated by the University of the Philippines to engage at regular intervals authorities in different branches of human learning from all countries of the world to deliver a series of lectures in that institution. This program, it is refreshing to note, is not merely an additional deferred, although beautiful, hope, the sole function of which is apparently to have something pleasant to anticipate. By a happy combination of circumstances the University succeeded in securing the services of Dr. Richard Goldschmidt, director of the Kaiser Wilhelm Institut für Biologie, Berlin, who is a biologist of international reputation, to give a series of ten lectures on sex determination. A bright augury for science in the Philippines was the enthusiastic response accorded by the public and by the local press to the speech given by Doctor Goldschmidt at a banquet tendered in his honor in which he advocated closer attention to pure science. Of course, Doctor Goldschmidt's series of formal lectures was most interesting and valuable; but if he had done nothing more than to influence the prevailing opinion in this country to adopt a healthier attitude of mind toward research in what imputedly, by contrast with so-called practical science, is impractical science, certainly all the trouble that the distinguished guest may have experienced in accepting this lecturership has been amply justified. There is hope that the patient scientist in his laboratory is fast coming into his own and that we will soon cease to regard with a merry chuckle, like Swift in *Gulliver's Travels*, the professor who spends eight years trying to extract sunshine out of a cucumber.

If we cannot afford to send our scientific men on regular periodical pilgrimages to famous institutions abroad, by all means let us have the only other alternative—continue to get the renowned authorities from these famous institutions to come to us with reasonable frequency. The lectureship established by the University will do a great deal to fill this long-felt need. Likewise, another avenue in the same direction has been opened a couple of years ago by the Board of Regents but has not yet been used. We have reference to the Baker Memorial Professorship, which provides for the salary and travelling expenses of a succession of visiting professors for the College of Agriculture for periods ranging from several months to one year.

ASEXUAL INHERITANCE OF TWIN CHARACTER OF BANANA BUNCHES[1]

T. MERCADO AND J. M. CAPINPIN
Of the Department of Agronomy

WITH SIX TEXT FIGURES

The selection of bud mutations is a method of improving banana plants. Because the important commercial varieties of bananas are seedless and are either self- or cross-sterile, their improvement through the production of new seedling varieties is a difficult work and selection of bud mutations becomes an important way of amelioration. Several cases of bud mutations have been reported in different countries where banana is cultivated. Some of them are grown commercially. A search for variants, therefore, constitutes a fundamental effort to improve Philippine bananas, particularly Latundal (*Musa sapientum* L. var. *cinerea* (Blanco) Teodoro) and Buñgulan (*Musa sapientum* L. var. *suaveolens* (Blanco) Teodoro) two of our commercial varieties. According to our two years' experiments on these two varieties they are cross-sterile with either Canton, which is seedy, or Gloria (*Musa sapientum* L. var. (Blanco) Teodoro), which is seedless. Latundal is susceptible to wilt and Buñgulan has very weak stalks. The clon under report is supposed to be a variant of Buñgulan variety. For convenience we shall call this variant Cambal (twin) banana. The twinnings of the bunches were found in various parts of the fruit stalks.

The main object of this report is to record the degree of asexual inheritance of the twin character of the Cambal banana.

The observations were made on the College Campus from February, 1926, to December, 1928, a period of nearly three years, covering two asexual generations of the plant.

Some cases of variations and abnormalities observed in bananas

Variations and abnormalities in bananas with respect to undeveloped hands in the bunch, premature appearance of inflorescence, protrusions of two shoots in a stalk, formation of hands at the staminate flower region, colored fruits, size of stalk, twinning of fingers and buds, and a commercial variant have been observed by different men. The first four cases, according to Dr. L. G. Gonzalez, pomologist of this College, could be duplicated artificially. The following is a description of some abnormalities and variations. Several of these variations have been described by Fawcett (1921) and cited by Mendiola (1926) in his book.

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[1] Experiment Station contribution No. 628. Prepared in the Department of Agronomy under the direction of Dr. N. B. Mendiola. Report read before the Los Baños Biological Club, March 7, 1929.

1. *A tall stalk from a dwarf clon.* A tall stalk from a dwarf variety, known as Chinese, or Canary banana (*Musa cavendishii* Lamb.) was reported by Fawcett. Due to its height, it was called male by the natives.

2. *Colored fruits.* In one of the "Claret" bunches was found two hands of green fingers and one hand of both claret and green fingers. One finger was "half green and half claret". This was reported by Fawcett (1921).

3. *A commercial variant.* Jamaica, or Gros Michel, banana is a supposed variant of Martinique or Pouyat banana, according to Fawcett. This variant is tall and bears fruit in about one and a half years. It is easily blown down by the wind, but as its fruit is adapted for export, it is a favorite with planters. According to Fawcett, "These plants bear long straggling bunches of large fingers. The fruit is much more hardy and will stand a lot of knocking about and a moderate amount of cold, for which reason the bunches are always shipped without packing." It is popular in the markets of Australia and New Zealand. This variety is an important export in Jamaica, Fiji, Costa Rica, Martinique, and Florida, and possibly the most important variety of commerce in the world.

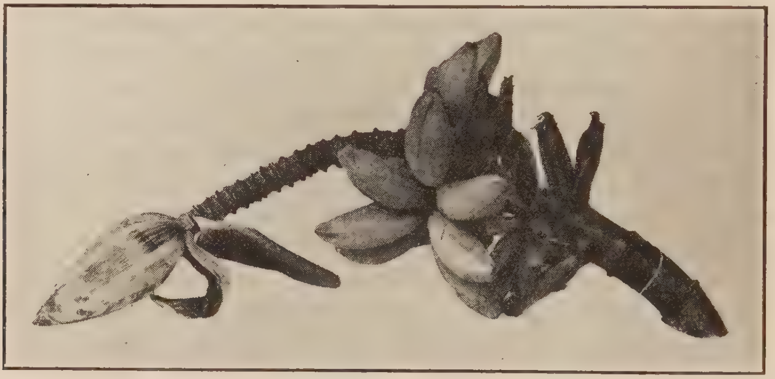

Fig. 1.—Bunch Showing Non-Developed Fruits.

4. *A stalk with two shoots.* A stalk with two shoots, one of which emerged about fifteen centimeters from the basal portion of another stalk, was found by Dr. Francisco M. Fronda, of this College, on Saba variety (*Musa sapientum* L. var. *compressa* (Blanco) Teodoro). It was found three weeks after the severe typhoon of November 5, 1927. The specimen was given to the Plant Breeding Division for further study. It was planted, given good care, and observations were made. The outgrowth developed into a big stem, while the main one died. The plant produced a normal bunch of fruit weighing 21.4 kilograms.

5. *Twin fingers and buds.* Twinning in banana has been observed in some varieties. The most common case of banana twinning is "where two or more fruits within the 'hands' are connected by fruit skin." In the Philippines this characteristic is common in Latundal variety. Sometimes two or more twin fingers could be found in one hand. Another case of twinning of fingers is found in a variety known in Central Luzon as "*Sabang Daop*", "*Binendito*", "*Oremus vobiscum*", or "*Inabaniko*" (*Musa sapientum* L. var. *flabellata*). The twinning of the fingers in the hand is a hereditary character of this variety. The fruits mature normally adnate in hand and the hands are fan-like in form. Other than in the twinning of the fingers, this variety resembles the Saba in many respects. The Saba does not produce twin fingers in the hand or very rarely.

A stalk with two flower buds was observed by Kander (1923) and cited by Mendiola (1926).

6. *Undeveloped hands in the bunch.* Undeveloped hands in a bunch have been found in nature or produced artificially.

Such a case may here be reported. These hands were found in one of the bunches of a variety in the barrio of San Antonio, Los Baños, in October, 1928. The first three hands of the bunch consisting of six hands were abnormally small, while the rest were normal.

Another case of undeveloped fruits in a bunch was reported by Mendiola (1926). The fruits were obtained by bagging the inflorescence before the pistillate flowers opened. A similar experiment was performed from September to December, 1928, in the Plant Breeding Garden of this College. The stigmas of the pistillate flowers of the first, second, third, fourth, and eighth hands were removed by means of a sharp knife before the flowers opened. Emasculation was made on September 22, 23, and 24. The other hands in the bunch were left untreated. On December 6, the fruits of the treated hands were found abnormally small while the untreated ones produced normal fruit. No seeds were produced in the treated fruit. A bunch showing non-developed fruit is shown in figure 1.

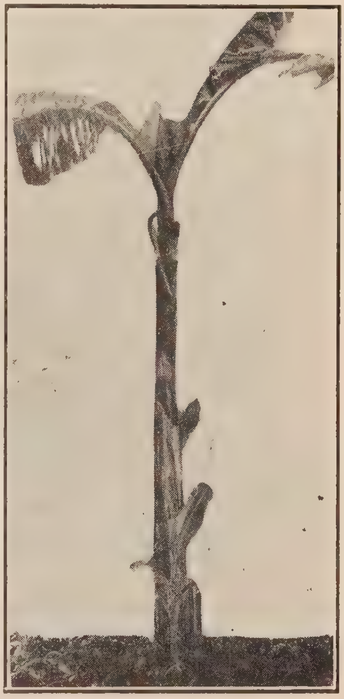

Fig. 2.—A STALK SHOWING PREMATURE APPEARANCE OF INFLORESCENCE.

7. *Premature appearance of inflorescence.* The premature appearance of the inflorescence in a stalk of Latundal variety was reported by Mendiola

(1922). The fruit ripened and was normal in taste and in color. The bunch was heavily laden with fruits. Another case was observed by the authors on Latundal variety in the College banana plantation in July, 1927 (fig. 2). The bunch was abnormally small but developed some normal fruit. A similar case was observed in the Buñgulan variety in San Antonio, Los Baños, in November, 1928. The bunch appeared on the upper half of the stalk, about twenty-five centimeters below the top. The bunch developed normally, but it was destroyed by the typhoon of November, 1928.

8. *Developed bunch at the staminate flower region.* Cases in which a developed bunch appeared at the staminate flower region were observed occasionally in Buñgulan (fig. 3) and Latundal varieties. Although the secondary group of developed hands was smaller in size than that in the first bunch, the fruit developed normally and became eatable. The cause of the development of the secondary group of hands is not known. However, it is probable that there was formation of the pistillate flowers in the staminate portion, which presumably developed either parthenocarpically or through natural pollination.

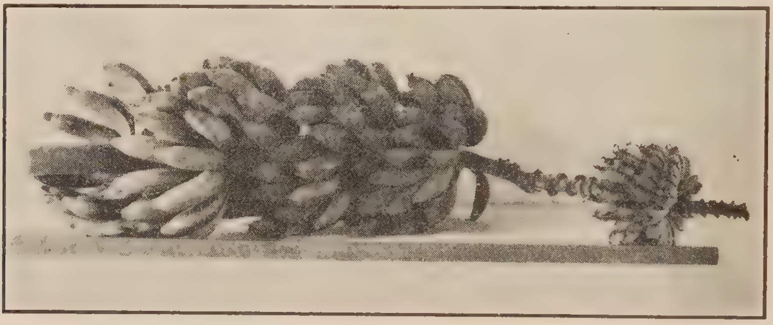

Fig. 3.—Bunch of Buñgulan Variety with Secondary Bunch.

MATERIALS AND METHODS

The material used in this study is a supposed variant of Buñgulan banana. The variant originated from Panitan, Capiz. Three suckers were brought to the College in 1923 by one of the students from Capiz.

Observations on this variety began in 1926, immediately after the appearance of the first double bunches in a stalk. The clon was then split into subclons and planted. Of the subclons which survived, four have fruited and records were kept. Weights and number of fingers in the hands were recorded and, whenever possible, pictures were taken. Several suckers from the subclon which produced the double bunches were planted for further study. All of these observations were made possible by the owner, Mr. Amado Andrada, 1928 graduate from this College, and his brother.

RESULTS

Results of this work are shown in tables 1, 2, and 3.

Table 1 shows the number of hands and fingers on two of the stalks which produced double bunches each.

Table 2 gives the number of hands and fingers of the triple bunches.

Table 3 gives the production of the Cambal variety from 1926 to December, 1928. It shows the degree of inheritance of the twin character of the Cambal banana.

DISCUSSION OF RESULTS

Description of the bunches produced by the plant.

The original clon. Two stalks of the original clon fruited. The first stalk produced a single bunch which resembled a bunch of Bungulan banana. In 1926, another stalk produced twin bunches, reported by Capinpin (1926).

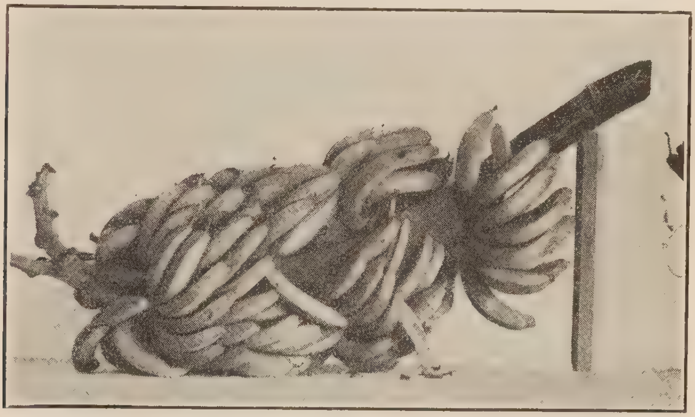

Fig. 4.—Single Bunch with Twinned "Hearts".

Each of the vegetative buds originated from the parent corm which developed into separate stalks and were then enveloped by leaf-sheaths of the stem. Although no count was made on the number of hands and fingers of the two bunches, they were similar in size and degree of maturity.

These twin bunches were exhibited in the Los Baños Elementary School on Garden Day, February 2, 1926.

Subclon 1. This subclon has so far produced only three bunches. The first two bunches produced were single. There was no sign of twin character at all. Although the third bunch produced was also single, it exhibited a sign of twin characteristics. The bunch was normal, but the flower bud split into two below the pistillate flower on the last hand of the bunch, the twinning of the staminate flowers occurring four centimeters from the last hand of the bunch or at the neuter-flower region. Thus the original flower bud split into two buds, forming two "hearts" (fig. 4).

Subclon 2. Only one stalk in subclon 2 fruited, yielding twin bunches. The bunches were harvested on September 27, 1928. The two bunches developed normally and ripened at the same time, the total weight being 23.8 kilograms. The twinning occurred 15 centimeters from the first hands of the two bunches (fig. 5). The number, size, and shape of fingers of one bunch were the same as those of the other.

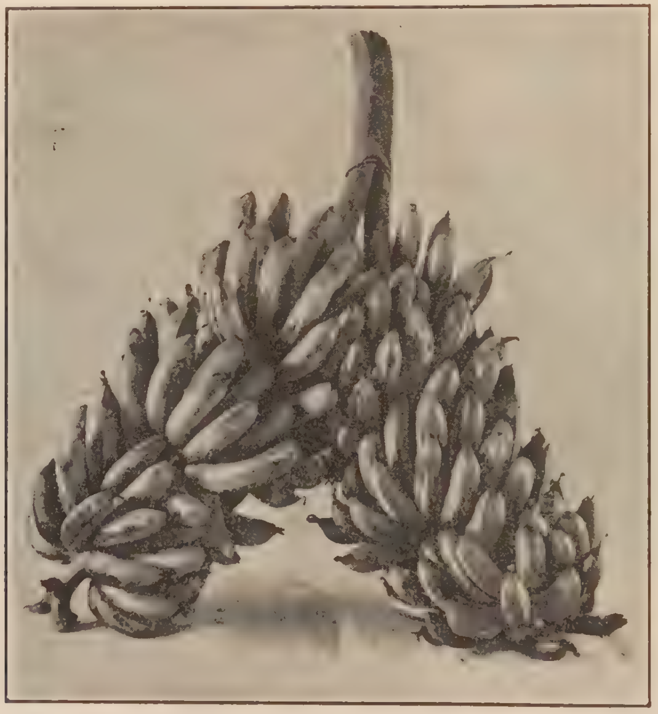

Fig. 5.—Matured Twinned Bunches.
Note the uniform size of fingers.

The hands and fingers in each bunch were counted separately. As seen in table 1 (left side), pairs of hands 1, 3, 6, 8, 9, and 10 of the two bunches of stalk I had the same number of fingers, ranging from 7 to 14. Pairs of hands 1 and 2 had 14 fingers each; 6 and 9, 12 fingers each; and 8, 10, and 11, 7 fingers each. Pairs of hands 2, 4, 5, and 7 had varying number of fingers. Hand 2 of bunches A and B had 14 and 13 fingers respectively; hand 4 of bunches A and B, 12 and 13 fingers, respectively; hand 5 of bunches A and B, 13 and 12 fingers, respectively; and hand 7 of bunches A and B, 11 and 12 fingers, respectively.

Although the number of fingers in hands 2, 4, 5, and 7 varied, each bunch had the same number of hands and totalled the same number of fingers. Each bunch had a total of 120 fingers and an average of 12 fingers in each hand.

Subclon 3. Two stalks of subclon 3 so far have fruited. The first stalk produced twin bunches and the second, a single bunch. Twinning of the two bunches which subclon 3 produced occurred six centimeters from the first hand upward, of bunches A and B. Such twinning was near the curvature of the first stalk. As shown in table 1 (right side), the number of fingers in each pair of hands varied, except in pairs of hands 4, 5, and 6, which had 10 fingers each. Hand number 1 of bunch A had 12 fingers, and of B, 14 fingers. Pair of hands 2 of bunches A and B had 10 and 12 fingers, respectively; and of hands 3 of bunches A and B, 13 and 10 fingers respectively. The two bunches varied slightly in the total number of fingers, but each gave an average of 11 fingers on each hand.

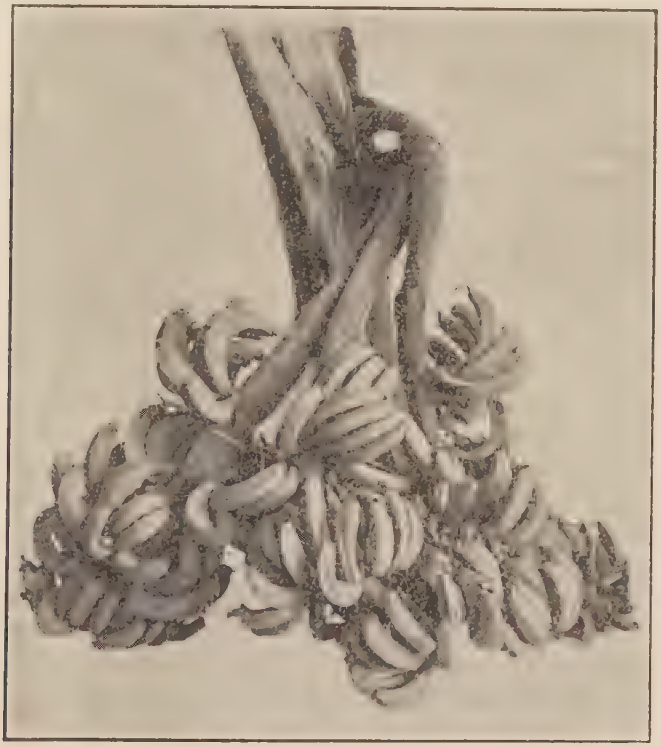

Fig. 6.—Tripled Bunches.

Subclon 4. Three stalks of subclon 4 fruited. The first stalk had twin bunches. The protrusion of the flower buds of these double bunches was observed during September and October, 1927. Observations were made on the development of the flower buds from the time the buds appeared to the time when all the pistillate flowers were distinctly separated from the staminate flowers.

On September 30, the two "hearts", or flower buds, were seen from the top of the stalk. On October 13, all the pistillate flowers of the two bunches were out and on October 21, the two flower buds produced no pistillate flowers at all. It was found in the twin bunches that the period from the time of the appearance of the flowers to the time when all the pistillate flowers were clearly seen lasted for nearly three weeks.

The second stalk of the same subclon produced triple bunches. They were brought to the laboratory and studied on December 4, 1928. The bunches were destroyed by the typhoon of November, 1928. Although they were immature, descriptions of each bunch were made. The twinning of bunches A, B, and C was found on the upper half of the fruit stalk. The first twinning occurred thirty centimeters below the curvature of the fruit stalk inside the bracts. The twinning of the other two bunches occurred twenty-three centimeters above the first hands of bunches A and B. There was a single flower stalk which originated from the parent corm. The three bunches looked alike (fig. 6).

It may be seen in table 2 that bunches A and B had 11 hands each while bunch C had only 10 hands. Hands 1, 2, 6, and 7 had the same number of fingers in bunches A, B, and C. Hands 1 and 2 of the three bunches had 12 fingers each and hands 6 and 7, 10 fingers each. Hands 3 and 4 of bunches A, B, and C had 12, 10, and 12 fingers each, respectively. Hand 5 of bunch A had 9 fingers; of bunch B, 10 fingers; and of bunch C, 12 fingers. Hand 8 of bunches A and B had 10 fingers each, while that of bunch C had 11 fingers. The fingers of hands 9 and 10 could not be compared for some of them were destroyed by a typhoon. Hand 11 of bunch A had 10 fingers; of bunch B, 11 fingers; and of bunch C, none.

SUMMARY AND CONCLUSIONS

The five clons of Cambal banana under study produced 11 stalks from 1926 to 1928. Of these eleven stalks six yielded a single bunch each; four stalks, twin bunches each; and one stalk, triple bunches. The two stalks of the original clon produced three bunches, two of which were twins, and the other single. Although subclon 1 produced three stalks with a single bunch each, there was sign of inheritance in one of them. Twin "hearts" were produced. One stalk of subclon 2 and one of 3 gave twin bunches. Six bunches from three stalks of subclon 4 were produced. One stalk produced a single bunch; the other stalk, double; and the third stalk, triple. The 11 stalks of the Cambal banana produced 17 bunches having six bunches more than 11 ordinary stalks of banana would produce. The single bunches produced by this plant were very similar to those produced by the Buñgulan.

Since the four subclons from the original plant possessing twin bunch character produced triple, double, and single bunches in the following asexual generation, there is therefore an indication that the twin character of the original plant is inherited vegetatively.

The twin bunch character, having been found inherited vegetatively in the offspring, interested some students. Some of the suckers have been distributed to other parts of the Islands. Some were taken to Iloilo, some to Occidental Negros, and others to Laguna. Undoubtedly this plant is being propagated around Panitan, Iloilo, its native place.

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TABLE 1

Number of hands and fingers of double bunches.

NUMBER OF HANDS	STALK I		STALK II	
	BUNCH A	BUNCH B	BUNCH A	BUNCH B
	fingers	*fingers*	*fingers*	*fingers*
1	14	14	12	14
2	14	13	10	12
3	14	14	13	10
4	12	13	10	10
5	13	12	10	10
6	12	12	10	10
7	11	12		
8	11	11		
9	12	12		
10	7	7		
Total.....	120	120	65	66
Average...	12	12	11	11

TABLE 2

Number of hands and fingers of triple bunches

NUMBER	BUNCH A	BUNCH B	BUNCH C
	hands	*hands*	*hands*
1	12	12	12
2	12	12	12
3	12	10	12
4	12	10	12
5	9	10	12
6	10	10	10
7	10	10	10
8	10	10	11
9	?	?	12
10	12	?	10
11	10	11	none
Total.....	109	95	113
Average...	10.9	10.55	11.3

TABLE 3

Production of single, double, and triple bunches of "Cambal" banana

CLON	NUMBER FRUITING	SINGLE BUNCH	DOUBLE BUNCHES	TRIPLE BUNCHES	TOTAL PRODUCTION
	stalks	*stalks*	*stalks*	*stalks*	*bunches*
Original clon..	2	1	1	—	3
Subclon 1.....	3	3[a]	—	—	3
Subclon 2.....	1	—	1	—	2
Subclon 3.....	2	1	1	—	3
Subclon 4.....	3	1	1	1	6
Total........	11	6	4	1	17

[a] One of the bunches had twin "hearts".

STUDIES ON THE DEVELOPMENT AND FEEDING HABITS OF POLYPEDATES LEUCOMYSTAX (GRAVENHORST), WITH A CONSIDERATION OF THE ECOLOGY OF THE MORE COMMON FROGS OF LOS BAÑOS AND VICINITY[1]

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AND

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WITH ONE PLATE AND FOUR CHARTS

Frogs and toads are generally believed to be beneficial in that they are efficient eradicators of insect pests. The basis for this belief is that these animals are to a large extent insectivorous. Usually, however, no distinction is made as to whether their diet consists of beneficial or of harmful insects.

Object of the present work

In the present study, attempts have been made to find the solution of the following problems: (1) habits and development of *Polypedates leucomystax;* (2) monthly range of food for a period of one year; (3) and supplementary observations on the ecology of other common frog species in Los Baños and vicinity.

Time and place of the work

The work covered a period of approximately seventeen months, from October, 1927, to February, 1929. Experiments and observations were conducted in the laboratory of the Department of Entomology, College of Agriculture; on the College farm; and in the neighboring farms in Los Baños.

Review of literature

Taylor's (1920) extensive treatise on Philippine Amphibia contain only some passing remarks on the food of a few species. Outside of this one reference, the writers could find no mention in literature of the feeding habits of Philippine frogs.

Acknowledgments

The writers are under obligation to Dr. L. B. Uichanco, professor of entomology and head of the Department, for valuable suggestions and

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[1] Portions of the material embodied in the present report have been presented as graduation thesis in the College of Agriculture for the degree of Bachelor of Science in Agriculture, by the junior author. Experiment Station contribution No. 625. Received for publication July 1, 1929.

criticisms during the preparation of the paper. We also gratefully acknowledge the valuable help of Mr. S. M. Cendaña, instructor in entomology, in the identification of some of the insects found in the stomachs of the frogs examined.

MATERIALS AND METHODS

Field trips and collections

Observations on the ecology of the different species were made in a series of trips to the farms in Los Baños, to various places on Mount Maquiling and to the creeks and rivers of Los Baños. Materials for study in the classification and identification of the different species were also collected.

The species of frogs included in this report are: *Rana magna* Stejneger (palakang kabkab—Tagalog), *Rana vittigera* (Wiegmann) (palakang tubigan), *Rana moodiei* Taylor (also called palakang tubigan locally), *Rana woodworthi* Taylor, *Oxyglossus laevis* Günther, *Rana similis* (Günther), *Cornufer corrugatus* (Duméril), *Cornufer meyeri* (Günther), *Polypedates leucomystax* (Gravenhorst) (palakang saguing), *Kaloula picta* (Duméril et Bibron) (palakang bato).

Observations on feeding habits

Observations on the feeding habits of frogs were conducted both in the field and in the laboratory. The feeding habits of frogs were determined by dissection and examination of stomach contents, which were classified with the aid of a dissecting microscope. The percentage of each food constituent was then computed on the basis of the amount of food found in the stomach of each individual. All determinations were volumetric.

Development of Polypedates leucomystax

For life history work a number of glass jars of about four to five liter capacity was used. Masses of eggs were put in these jars which were kept half-filled with water. The tadpoles were reared in the same containers. Observations on the rate of growth and development of the frogs were made largely under laboratory conditions. Supplementary field observations were also conducted. For growth determination, measurements of representative samples were taken every seven days. Samples of different stages of development were preserved in ten per cent formalin solution.

After the tadpoles developed into young frogs they were removed from the jars and confined in a wire cage (5-millimeter mesh) measuring about $1 \times 0.8 \times 0.5$ meters. To provide food for the frogs pieces of bread were soaked in sugar solution to attract flies and ants. The method was found satisfactory for the purpose.

RESULTS AND DISCUSSION

Local distribution

The area covered in the observations extends from Calamba to Bay, and from the shores of Laguna de Bay to the regions around Mount Maquiling, bordering the College of Agriculture campus.

Rana magna was found to be fairly abundant along mountain brooks and streams from Camp Eldridge to about 200 meters elevation on Mount Maquiling.

Rana vittigera was found to be a lowland form, and was encountered mostly in rice paddies at Calamba, Pansol, Los Baños, Bay, and in the vicinity of these towns. This species was also found in the irrigated fields of the College of Agriculture. Apparently it does not exist at an elevation higher than the Forest School (100 meters). This species is caught locally in great quantities by the people for food, and for bait in set lines for catching fish in Laguna de Bay.

Rana moodiei was found to be closely associated with *R. vittigera.* It is also a lowland form. This species is also caught for food and bait for set lines used in fishing.

Rana woodworthi is common along mountain streams at low elevations. It is confined mostly to the small streams between Camp Eldridge and the College of Agriculture. This species has not been found in the area extending from the College of Agriculture campus to the School of Forestry.

Rana similis is mostly confined to the marshy lowlands bordering Laguna de Bay, although it was also found in the lower course of Molawin Creek.

Oxyglossus laevis is a highland form. It is found mostly in mountain streams and rain pools scattered in the forests on Mount Maquiling. It can always be found in Molawin Creek from the College of Agriculture campus to 500 meters elevation in the Maquiling region.

Cornufer corrugatus is a mountain form. Its range of distribution is rather limited, being from the Forest School to the summit of Mount Maquiling.

Cornufer meyeri, like *C. corrugatus,* is a woodland form. It is found only on Mount Maquiling from about 200 meters to about 900 meters elevation. This species was found to be closely associated with *C. corrugatus.*

Polypedates leucomystax is the most common tree frog found at low elevations. It is evenly distributed throughout Los Baños and vicinity. It was found in fair abundance in the banana plantations around Calamba, Pansol, Los Baños, Bay, as far as the abaca and banana plantations near the Forest School. It was not encountered at an elevation higher than 300 meters.

Polypedates pardalis is a rare species. Only one specimen was seen in connection with the present work, and that was in the collection of the

Forest School. It was found by a forestry student in the abaca plantation near the campus of the School of Forestry.

Kaloula picta is abundantly distributed in the towns of Calamba, Pansol, Los Baños, Bay, and on the College of Agriculture farms. It was found to be common at low elevations, and not infrequently seen in sheltered places near houses.

Ecology of the frogs studied

a. *Rana magna* is the largest of Philippine frogs. It usually attains a body length (snout to vent) of 130 to 150 millimeters.

The natural habitat of this species is in the immediate vicinity of water, usually along the banks of mountain streams, running brooks, and pools. On still, cool nights they may be found perched on fallen logs and stones along the Molawin Creek awaiting the arrival of suitable prey. They are less active during the day. Along the banks of the creek they occupy some strategic position from which a large part of the surrounding area may be viewed and are always on the lookout. At the approach of an enemy they take to water at once and come back to the surface again only after reassuring themselves that the danger has passed. At night they were observed or their voices were heard along the creeks, where probably they were in search of food or were engaged in reproductive activities. Like the other species of frogs, *R. magna* is highly insectivorous, but on account of its frequent visits to aquatic environment, its diet differs somewhat from other species.

Field and laboratory observations on the feeding habits of this species were made. The results of the examination of the contents of thirty well filled stomachs show that the food of *R. magna* consists chiefly of animal material, the amount having been calculated to represent more than 91 per cent of the entire bulk. In bulk, insect food predominates. It represents about 75 per cent. Other animal food, besides insects, which was found in the stomachs of *R. magna* were spiders, centipedes, fish, tadpoles, fresh water snails, and shrimps, named in the order of abundance.

Of the insect food, the highest percentage was represented by Orthoptera, which consisted mostly of grasshoppers and crickets. Coleoptera (beetles of various kinds) also entered into the dietary of the frogs. *R. magna* may be considered a voracious feeder of Isoptera (mostly winged termites) as evidenced by the finding in each of two of the stomachs 198 termites.

The economic status of this species is presented in table 5.

Apparently, *R. magna* habitually stays in freshwater streams. This statement is based both on field observations and the finding in its stomach of aquatic organisms, such as fresh-water snails (*Melania* spp.), half-beak (*Dermogenys viviparus* Peters), and tadpoles.

Some of the natural enemies of *R. magna* that came to the attention of the writers are birds, lizards, snakes, and man. Because of the size of this frog it is the favorite amphibian specimen in the zoölogical laboratory; as a consequence, great numbers are killed from year to year.

b. Rana vittigera. This species is strictly a lowland form. It is commonly found in rice fields, irrigated fields of sugar cane, corn, and other cultivated crops, but most frequently in the rice paddies. Like *R. magna*, it frequents fresh-water streams, but is more limited in its distribution, for it was not found at an elevation higher than the Forest School. At night, especially after a cold, rainy day, it has been observed visiting rice and corn fields which serve as the feeding grounds of insect pests. Examination of stomach contents of frogs captured from the rice and sugar cane fields showed that insect pests constituted the major portion of their diet.

Examination of 55 stomachs of frogs collected at random revealed the presence of insect materials belonging to nine orders, besides centipedes, spiders, earthworms, fresh-water snails, fresh-water crabs, fish, and slugs. These orders were Orthoptera, Coleoptera, Isoptera, Dermaptera, Hymenoptera, Odonata, Diptera, Hemiptera, and Lepidoptera. The total animal food formed about 94 per cent of the total bulk of stomach contents. Of this amount, 67.45 per cent consisted of insects.

Table 5 shows the Orthoptera (mostly crickets and grasshoppers) represented the greatest bulk of the insect food. Coleoptera (beetles of various species), Isoptera (mostly termites), earwigs (Forficulidae), Formicidae (mostly ants), Lepidoptera (mostly caterpillars) were also represented in the stomachs of *R. vittigera.* Besides this food, other animals, in smaller numbers, were included in the diet of this species. Fifteen of the 55 stomachs examined were found to contain spiders (Arachnida), Chilopoda (centipedes), and Annelida (earthworms). (Refer to table 5.)

The fresh-water organisms that were found in the stomachs of *R. vittigera* were shrimps, snails, crabs, and fish. The finding of the aquatic animals in the stomachs of this species is an indication of their habit of frequenting fresh-water streams.

Like *R. magna* and other lowland forms, this species suffers from the attack of natural enemies. In several instances, a species of snake, *Natrix spilogaster* (Boie), which is common in rice fields where these frogs are abundant, was seen to swallow both adult and young frogs. Tubangui (1928) reported the presence of two trematode parasites, *Glyptelmins staffordi* Tubangui and *Pleurogenes taylori* Tubangui, in the intestines of this frog.

c. Rana moodiei. This species, like *R. vittigera*, is a lowland form. It is fairly common in dense, shrubby vegetation growing along streams, as this is its favorite habitat. On cold, rainy days *R. moodiei* may often be found in groups of four to seven, perched in weed patches, usually not far from the protecting cover of a creek bottom. During the breeding season they establish themselves in grassy areas adjacent to the cultivated fields, and from there they make regular trips to the infested fields in search of food.

Although *R. moodiei* is a widely distributed species, its presence is sporadic in small areas. The lower course of Molawin Creek and other small streams of Los Baños are the favorite hunting grounds.

Interesting information as to the food habits of this species was obtained as a result of examination of stomach contents. About 94 per cent of the stomach contents consisted of animal material. As usual, insect food was predominant. Of all the species examined, this frog was found to have eaten aquatic organisms in the largest quantities. They were mostly water crabs and shrimps referable to the genera Potamon and Palaemon, respectively.

Spiders occurred in 10 of the 50 stomachs examined. Apparently only a few centipedes are eaten, as they were found in the stomachs of only five of the 50 specimens examined. Detailed information on the food habits of this species is presented in table 5.

One of the worst enemies of this species is the *bayawak*, *Varanus salvator* (Laurenti). On many occasions the writers observed this species being chased by this common lizard. It is not improbable that *R. moodiei* may be eaten by other larger vertebrates also.

d. *Rana similis* is also a lowland form. It can be distinguished from the other species by the presence of two creamy lines along either side of the body. It is usually found along the shallow marshes bordering the shores of Laguna de Bay. The heavy undergrowth along streams, irrigating ditches and canals serve as the favorite hunting grounds of this species. Sometimes it may be found under fallen logs and piles of fallen dry leaves. Observations on its activities showed that it readily takes to water to escape enemies, but never remains in it for any considerable length of time. There is active feeding only at night, as *R. similis* was seldom found during the day. It is sensitive to heat; its means of protection being to hide under leaves and stones.

Its food consists of small active creatures that prowl at night. Examination of their stomach contents revealed a preponderance of animal materials, the most conspicuous of which were insects belonging to different groups. The greatest amount of insect material was represented by Isoptera (mostly termites) and Hymenoptera (mostly ants).

An evidence of the frequent visits of this species to fresh-water streams is the finding in their stomachs of water beetles of the family Hydrophilidae. The other materials that formed the bulk of the stomach contents were spiders and centipedes.

Like other species of *Rana*, this species has the habit of congregating around pools and streams to breed. Their whereabouts during this time may be detected by the soft voices of the males, which, according to Kirkland (1904), is the sweetest sound in nature.

e. R. woodworthi was found to be closely associated with *R. vittigera* and *R. moodiei*, both of which are lowland forms. It is common along mountain streams at low elevations. This species is apparently not abundant, as only eight specimens were taken from the small Anos stream which empties into Laguna de Bay. The frogs were captured in a densely wooded creek bottom which afforded direct passage from the shrubby vegetation of its favorite habitat to the midst of an agricultural community.

Examination of the stomach contents of eight frogs showed that about 94 per cent of its food was of animal origin composed mostly of insect materials. Of the insects found were grasshoppers (Locustidae), crickets (Gryllidae), and green locusts (Tettigoniidae), earwigs (Forficulidae), dragon flies (Odonata), termites (Isoptera), beetles (Tenebrionidae), and caterpillars.

Other species which contributed to the diet of *R. woodworthi* were spiders, centipedes, earthworms, snails, and slugs. The percentages of these materials are shown in table 5.

From these findings it may be said that this species is an effective enemy of insects and other animals, such as spiders, centipedes, earthworms, and some species of molluscs. The presence of snails in the stomachs is an evidence that this species is also an occasional visitor to fresh-water streams.

f. Oxyglossus laevis is found both in lowland and upland streams. The mouths of rivers, mountain brooks, and pools are some of the favorite hunting places of this species. They are found in water, apparently in search of food. In the forests they have been seen hunting for food in piles of leaves and underneath logs.

Both terrestrial and aquatic animals have been found in the stomachs of this species. No less than 22 different items were recognized (tab.le 5). The materials identified were spiders, shrimps, snails, tadpoles, crabs, centipedes, and insects referable to at least ten orders.

The largest insect food item was Orthoptera (mostly crickets and grasshoppers). Insect food other than Orthoptera was: Coleoptera (beetles), Hymenoptera (mostly ants), Isoptera (termites), Odonata (dragonflies), Homoptera (nymphs of cicada), Lepidoptera, and Diptera.

Spiders were found in varying amounts. A little less than one fourth of the 100 stomachs examined contained spiders which at times amounted to 95 per cent of the entire stomach contents. Centipedes were also represented but few were found.

The aquatic animals included in the diet were fresh-water shrimps, fresh-water snails, and fresh-water crabs. It can also be said of *O. laevis* that it frequents fresh-water streams.

Of all the species studied, *O. laevis* is considered the most omnivorous.

It was found that *O. laevis* was most active during the breeding season after which it was seldom encountered in the open; probably it hides in quiet, unexposed places.

g. Cornufer corrugatus. Taylor (1922) characterized this species as a typical example of woodland forms. *C. corrugatus* was found only in the regions about Mount Maquiling, from the elevation of the Forest School to about 100 meters below the summit. It was rarely found in the vicinity of fresh-water streams. In all likelihood it confines its activities to the forests looking for food. Most of the time this species was found creeping underneath logs probably waiting for their prey. It was observed to be sensitive to noise or disturbance in the woods, being attracted to it, as possible prey, but was easily frightened at the sight of enemies.

Examination of 20 stomachs showed that *C. corrugatus* is highly insectivorous. About 74 per cent of the stomach contents were insects, the most conspicuous of which were termites and ants. Coleoptera, represented by Tenebrionidae and Anthribidae, were also found in the stomachs of *C. corrugatus.* The other insect materials eaten by *C. corrugatus* were earwigs (Forficulidae) and dragonflies (Odonata).

The other food materials found in the stomachs of adult *C. corrugatus,* indicative of their terrestial habits, were spiders and centipedes.

Both actual field observations and results of examination of stomach contents confirmed the assumption that this species does not frequent fresh-water streams for its food.

h. Cornufer meyeri is also a woodland form. It differs from *C. corrugatus* in that both adult and young of this species were found to be very fond of staying near very moist places. During the day they were frequently observed moving about the forests searching for food.

Examination of the stomach contents of 15 specimens showed animal substances amounting to 97.9 per cent of the entire bulk, the most conspicuous portions being insect material. (See table 5.) Termites (Isoptera) and ants (Hymenoptera) were the best represented. The other insect materials found in the stomachs of *C. meyeri* in the order of abundance are as follows: earwigs (Forficulidae), beetles (Tenebrionidae), dragonflies (Odonata), and beetles of the family Anthribidae. Spiders and centipedes were also found but were represented by very small percentages of the total bulk of stomach contents.

i. Kaloula picta is a small narrow-mouthed frog, commonly mistaken for a toad. It was frequently found burrowing under loose earth or taking shelter under stones and piles of decaying leaves. This species was found to be strictly nocturnal in its feeding habits. It is confined to lowlands. In Los Baños and vicinity it was found in great abundance.

Taylor (1922) observed that *K. picta* did not have the habit of approaching water except during the breeding season when many individuals were found congregated about rain pools to lay their eggs. The writers on many occasions confirmed Taylor's observation. During one of the nightly trips, as many as 50 to 60 frogs of this species were counted on the banks of one of the shallow pools near the sugar mill of the College of Agriculture.

Observations on the feeding habits of this species were interesting. Just after sundown, they were seen to emerge from their abode or hiding place and sally forth in search of prey. They were even seen hopping along roadsides, in gardens, sugar cane fields and on the campus. The writer once observed three *K. picta* holding a picnic on winged termites that had fallen under one of the electric lights on the campus. Under close observation the writer found that dead or motionless insects did not attract the attention of the frogs. Caterpillars and millipeds were not molested while they remained curled up, but as soon as they moved they were at once snapped up one by one with great rapidity.

This species, although small in size, compares favorably with the other species with respect to the consumption of insect food. Examination of 50 stomachs revealed that the diet of *K. picta* consisted mainly of animal ingredients, the major portion of which consisted of insects.

In the amount of Orthoptera eaten, there is a marked falling off compared with the other species, as only 9.36 per cent was represented. This difference is largely accounted for by the fact that *K. picta*, being nocturnal in habits, must prey largely on insects that are active in the night. Isoptera, mostly winged termites, and Hymenoptera, mostly ants, were also found to be eaten by *K. picta*. Other insect food, named in the order of abundance, were: Coleoptera (mostly ground beetles), Odonata (dragonflies), Diptera (mostly houseflies), and cockroaches (Blattidae). Animal food other than insects that were eaten by *K. picta* were spiders and centipedes.

One of the most important enemies of *K. picta* are the domestic fowls, especially chickens. It is deplorable that so many of them are killed and used as fish bait. The burning of fields after harvest often brings death to great numbers of them. For instance, when the sugar cane field near the sugar mill was burned, many of these frogs were found dead the following morning. Lawn mowers and rollers also kill many of them.

j. Polypedates leucomystax is the most common species found in Los Baños and vicinity. Locally, it is known as the banana frog (palakang saguing). Like the other species it is confined to low elevations, but on account of its more arboreal life, its activities differ somewhat from the other species.

P. leucomystax is mainly nocturnal in habits. It was not uncommon in the course of the present work to see at night a party of ten to fifteen perched on twigs and branches of trees awaiting the arrival of insects. Oftentimes this species was seen in cultivated fields and other places where insect life was abundant. It was observed to visit vegetation near electric lights where it was able to capture large numbers of insects. It was seen stationed beneath the lights devouring every insect it could catch. During the day these frogs may be found clinging to the leaves and axils of banana plants.

A detailed study of the activities and life habits of this species is reported below.

Food of adult Polypedates leucomystax

One of the most reliable criteria by which the feeding habits of the frogs may be determined is careful examination of the contents of a sufficiently large number of stomachs collected at different months of the year over a fairly wide territory. While it is true that field observations may furnish important circumstantial evidence as to the nature of the food taken by the frogs, yet the method is quite slow and requires painstaking effort, which in most cases produces unsatisfactory results. Also, in the procedure just mentioned, the absolute identification of the kind and quantity of the materials eaten by the frogs can not be made at long range. Examination of stomach contents not only reveals the nature and condition of the food, but, as Beal (1904) termed it, "constitutes the court of final appeal".

In the laboratory, the contents of 526 well filled stomachs of *P. leucomystax*, taken from the farms of the vicinity of Los Baños and the College of Agriculture in different months of the year, were examined, and their composition analyzed. Of these, 305 stomachs were taken from female frogs, and 221 from males. With the exception of some fresh specimens, all the stomachs were examined after being preserved for some time in a 10 per cent solution of formalin. The number of stomachs examined by months during 1927 and 1928 were October, 41; November, 45; December, 49; January, 47; February, 35; March, 41; April, 43; May, 50; June, 46; July, 47; August, 38; September, 44.

The animal food constituents found in the stomachs of *P. leucomystax* were all identified as terrestrial forms, such as insects, centipedes, spiders, earthworms, and garden slugs. Chart 1 shows that these animal food constituents were eaten by the frog the year round, in varying amounts, ranging from 96.4 per cent in September to 99.2 per cent in July; in other months of the year the results were almost uniform, ranging from 97 to 98 per cent.

Of the total amount of animal food 80.5 per cent were insects and about 17.8 per cent spiders, centipedes, earthworms and slugs. The remaining 1.71 per cent consisted of vegetable and inorganic food.

In the consumption of insect food, *P. leucomystax* compares favorably with the other species of frogs studied (tables 2, 3). November to January was the period of greatest consumption of insects, when they formed more than 88 per cent of the stomach contents. From May to July, insects provided more than four fifths of the frog's sustenance, the amount varying from 83.65 to 86.75 per cent. In other months of the year, insect food furnished more than half of the frogs' diet, a rather remarkable proportion when the factors affecting the periodicity and abundance of terrestrial forms under local conditions are considered. Uichanco (1926) is authority for the statement that "in Los Baños and vicinity, for instance, general insect collecting is much more profitable through May, June, and July and through November, December and January than in other months."

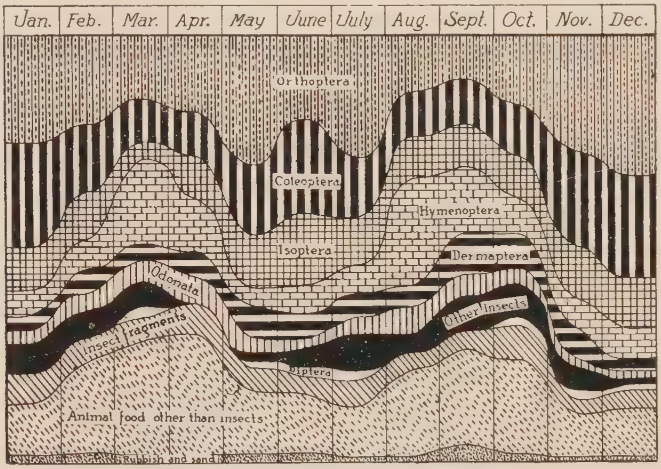

CHART 1

At least nine orders of insects were represented in the stomach contents of *P. leucomystax,* namely: Orthoptera, Coleoptera, Isoptera, Hymenoptera, Dermaptera, Odonata, Lepidoptera, Hemiptera, and Diptera.

Orthoptera alone represented more than one fourth of the annual consumption of insect food. Grasshoppers (Locustidae) formed 11.46 per cent. The highest percentages of stomach contents in the form of grasshoppers occurred during a period covering the months of January, May, July, November, and December during which they were found in more than 50 per cent of the 526 stomachs examined. The nature of damage done to vegetation which is directly traceable to the Locustidae is too familiar to farmers to require further discussion. The number of crickets (Gryllidae) was calculated to represent an average of 8.06 per cent of the yearly sustenance of the species. Long-horned locusts (Tettigoniidae) which cause considerable injury to young foliage are also relished by the frog, while the cockroaches (Blattidae) some of which are most noxious insects, are also eaten by frogs. So that, if judged only on the basis of the nature of the work it does in reducing these insect pests, *P. leucomystax* may be considered a blessing to the farmers.

Coleopterous insects were represented by about 16 per cent of the yearly insect food consumption. In this order seven families were identified as follows: Cerambycidae, Chrysomelidae represented by the yellow squash beetles (*Orthaulaca similis* Olivier), and the coconut leaf miner (*Promecotheca cumingii* Baly), Scarabaeidae, Cassididae, Tenebrionidae, Anthribidae, and Coccinellidae. The last named family consisted of beneficial species.

The 526 stomachs examined throughout the year all contained both winged and wingless termites (Isoptera). This comprised 10.61 per cent in March to 16.55 per cent in June. Among the species found were *Coptotermes travians* (Haviland) and *Leucotermes philippinensis* Light, both of which are known to attack furniture, forest trees, and even cultivated plants. Winged forms were also found.

Ants, Formicidae mostly, constituted 10.98 per cent of the contents of all the stomachs examined. The greatest number of ants was found in August on 32 of the 40 stomachs examined. The second period of increased consumption of ants was in March when 27 of the 41 stomachs collected were found to contain this food.

Dermaptera (earwigs), mostly *Proreus simulans* Stal, amounted to 5.59 per cent of the total yearly insect food. About 122 of the stomachs examined contained earwigs in varying amounts, from a few individuals to a stomach full. For instance, in the September and October collections, there were noted ten stomachs containing earwigs amounting to 90 per cent of the entire contents.

The terrestrial habits of *P. leucomystax* are once more revealed by the dragonflies (Odonata) in their stomachs. Table 2 shows the monthly range of Odonata as food of *P. leucomystax*. Dragonflies, as a rule, are active during daytime, so that very likely the frog catches them in the early morning. The frogs are probably able to capture dragonflies in the late afternoon, the time when frogs begin to come out from their sleeping quarters to start their night's work. Taken as a whole, dragonflies contribute 4.04 per cent of the annual diet of *P. leucomystax*.

Lepidoptera, mostly larvae of the banana leaf roller (*Erionota thrax* L.), was found, but in small quantities only. For example: in January, 1.35 per cent; February, 2.15 per cent; June, 3.2 per cent; July, 2.5 per cent; August 1.5 per cent; September, 2.7 per cent; October, 2.75 per cent; November, 2.15 per cent. It is most probable that the frogs would have eaten more larvae of the banana leaf rollers, were it not for the habit of the latter to hide in rolls in banana leaves.

The green soldier bug (*Nezara viridula* L.) and the Oriental cotton stainer (*Dysdercus megalopygus* Breddin) were also eaten by the frogs. The combined percentages of these items ranged from 1.4 per cent to 6.25 per cent, respectively. The lowest percentage was made in December probably because of the abundance of the other kinds of insect food. These bugs are known to cause appreciable damage to economic crops by sucking the sap.

Muscoid flies were also found in the stomach of *P. leucomystax*. Their presence is, however, insignificant, as they formed less than one per cent of the stomach contents.

The rest of the insect food consisted of unrecognizable insect fragments, calculated to be 5.37 per cent for the year.

Besides insects, *P. leucomystax* was found to eat centipedes, spiders, earthworms, and garden slugs. These food constituents formed about 17.79 per cent of the total annual diet of the species. Of this amount, spiders formed 6.98 per cent; centipedes, 6.95 per cent; earthworms, 2.98; and garden slugs, 0.88 per cent. The last mentioned animal may have been eaten only by accident. Chart 1 shows the monthly range of the food of *P. leucomystax*.

Food of young Polypedates leucomystax

Examination of 232 stomachs of young *P. leucomystax* collected throughout the year revealed food preferences differing somewhat from those of the adult collected during the same time. Table 4 shows that 99.21 per cent of the total stomach contents consisted of animal materials. As in the adult frogs, insects formed the bulk of the stomach contents. Less than one per cent (0.79 per cent) was composed of vegetable and mineral materials.

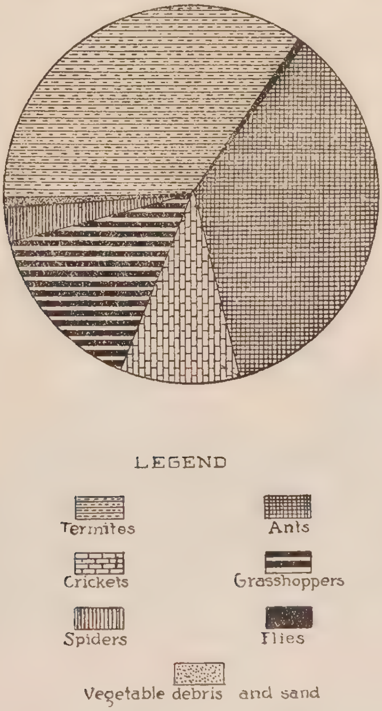

CHART 2

Of the 232 stomachs examined none was found to contain hard bodied insects, such as beetles and related species. Soft bodied insects, like ants, termites, crickets and grasshoppers, composed the major portion of the diet of young *P. leucomystax*. Chart 2 shows the relative proportions of the yearly food of young *P. leucomystax*.

Formicidae, mostly ants, formed a yearly average of 35.96 per cent. The monthly range of this food constituent is shown in table 4.

Isoptera supplied more than one third of the frogs' sustenance.

Crickets (Gryllidae) and grasshoppers (Locustidae) were also relished by the frogs.

Muscoid flies were also taken by the young frogs.

Like the adults, young frogs of *P. leucomystax* were also found to feed on spiders.

The vegetable and mineral constituents found in the stomachs of young *P. leucomystax* consisted mainly of small bits of grass and leaves and small particles of sand.

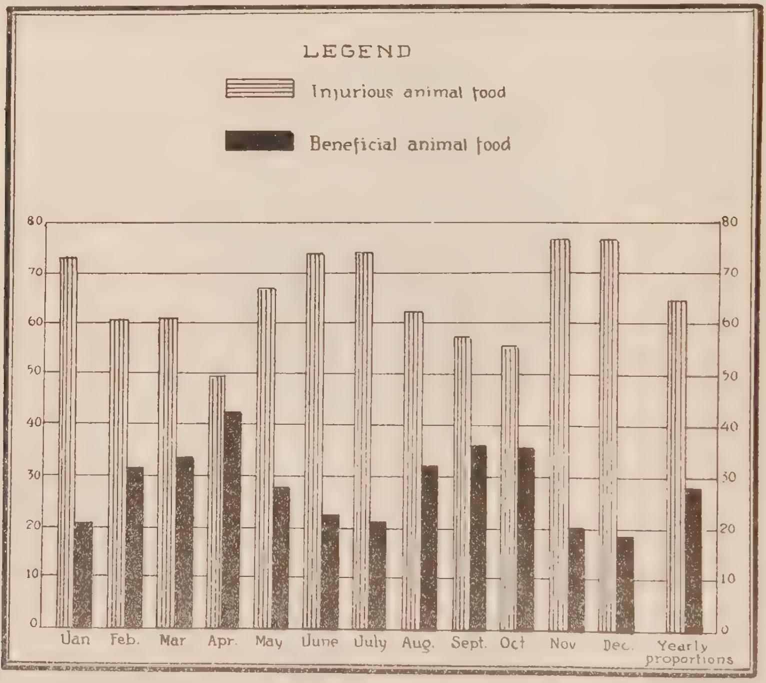

CHART 3

Economic status of animals eaten by P. leucomystax

An attempt was made to strike a balance between the appreciable work accomplished by the frog through its persistent attack on injurious species and the harm it does by destroying the beneficial ones. Chart 3 shows that its work in devouring noxious insect species is worthy of attention.

While *P. leucomystax* destroys a goodly number of beneficial animals, such as earwigs (Forficulidae), spiders, earthworms and some predatory lady beetles (Coccinellidae), yet it consumes proportionately much greater quantities of injurious insects. From table 3 and chart 3, it will be noted that the proportion of yearly consumption of noxious and useful insects of *P. leucomystax* is 64.83 per cent to 28.09 per cent, or a ratio of 2.3 noxious to one of beneficial insects.

Feeding by this species, as revealed by the stomach contents, appears to be indiscriminate, all kinds of animal life of convenient size coming within reach was consumed.

Postembryonic development of Polypedates leucomystax

a. Distinct external characteristics of both sexes. The female, as a rule, is much larger than the male. The average measurements taken of 195 adult females and 170 adult males were:

	Females *mm*	*Males* *mm*
Length, snout to vent	82	50
Length of snout	12	9
Length of head	25	18
Width of head	23	15
Diameter of eye	8	6
Diameter of tympanum	6	4
Eye to nostril	8.5	6
Length of fore leg	51	28
Length of longest finger	20	12
Length of hind leg	125	80
Length of longest toe	31	18
Diameter of finger disk	4	2
Diameter of toe disk	3	1.5

From the foregoing measurements it may be seen that the male is only about two thirds as large as the female. The male is further distinguished from the opposite sex by a thickening in the inner digit of the fore limbs, which appears during breeding season.

The color and markings vary greatly in the sexes. Color alone is not a safe criterion to distinguish a male from a female, for both sexes may possess almost the same color patterns and markings. The markings are usually four to six longitudinal lines on the back. Some have only a few dark, irregular spots. The color varies from light yellow to dark purplish brown, sometimes atmost black, with no markings visible. Both sexes are capable of changing color momentarily. A couple, when first captured, had a light yellow color with no visible markings, but after some time in confinement six longitudinal lines appeared on the back of each and the yellow color became dark brown. The color and markings soon disappeared and the animals became grayish with irregular spots scattered on the back. The color changes took place at irregular but frequent intervals.

b. Breeding season. No definite breeding season was found for this species in Los Baños and vicinity. It was observed that it breeds at almost any time of the year, provided there is sufficient water for oviposition. Under the Insectary at the College of Agriculture it is not uncommon to see masses of eggs deposited on the edge of pools around the posts, and sometimes on the ground near the water or on twigs and shrubs above the water.

c. Manner of oviposition. Mating is commenced before reaching the water. During mating the male has the habit of producing a series of loud, regularly recurring, slowtimed sounds which consist of two successive notes, the first high and second low. This song is presumably a love call to attract the female. Copulation does not take place, but fertilization of the eggs is accomplished by amplexation, a process in which the male clasps the female firmly, embracing her just behind the forelegs with his arms, and in this way the male is carried by the female on her back. As the eggs pass out from the cloaca of the female, they are fertilized by the spermatozoa discharged over them by the male. After the eggs are laid, the male leaves the back of the female (Pl. 1, fig. 18.).

d. Larval stages. The eggs are numerous. As many as 860 to 900 were counted to have been extruded in a single oviposition. They are almost spherical, creamy white, and measure from 1 to 1.5 millimeters in diameter. The eggs are invested in thin coatings of gelatinous substance which swell greatly upon contact with water. Two days after oviposition the eggs which were at first spherical become ovoid and then rapidly increase in length. By the third day a slight constriction was formed which divided the egg into head, body and tail regions. The spherical egg was thus transformed into a tadpole (Pl. 1, fig. 3). Three days after hatching the tail increased in length and two pairs of branching tufts, the external gills, arose from the sides of the neck (Pl. 1, fig. 4, 5). A day after the appearance of the first two pairs, the third pair made its appearance. These served as the first functional respiratory organs of the frog.

The newly hatched larva had no mouth and was presumably dependent upon the yolky material stored in the egg. When three days old, tadpoles became more active. The mouth appeared at the anterior end of the head. This organ is round, bordered by fleshy lips provided with papillae. The alimentary canal which was formerly broad and short (Pl. 1, fig. 11), increased in length, becoming tubular and convoluted in the form of reverse spiral at the end of the first week (Pl. 1, fig. 12). The anus was also formed three days after hatching. During this period the formation of the rudiments of the pancreas and liver was observed.

Simultaneous with the appearance of the mouth, a slit-like opening appeared on either side of the neck. These were the gill clefts, leading from the pharynx to the exterior.

Two weeks after hatching and soon after the formation of external gills, a fold of skin appeared on either side of the head, in front of the gills, the fold increasing backward over the gills, ultimately inclosing them in a gill chamber. The opercula commenced to form when the external gills were about to disappear and became fully formed when the latter were no longer in evidence. Internal examination of the opercula showed that the internal gills were concealed beneath them. The opercular folds fused with the body wall on the ventral surface along the right side. A spout-like opening remained on the left side which communicated with the gill chambers of both sides (Pl. 1, fig. 7). Newman (1926) and other writers interpret the operculum as a structure equivalent to the atrium of the Amphioxus. However, the homologies of these structures have not been fully established.

Four weeks after hatching the tadpoles began to feed voraciously and to grow at a much more rapid rate. The body became broad, and the tail larger, forming a powerful swimming organ.

At the beginning of the fifth week, rudiments of the hind legs appeared as a pair of small papillae at the root of the tail one on each side (Pl. 1, fig. 8), These papilla-like structures increased in size and on the sixth week became divided into joints until the hind legs were finally formed (Pl. 1, fig. 9).

The formation of hind legs was closely followed by that of the fore legs, which became visible about a week later. The fore legs were, however, formed much earlier than their actual functional appearance, almost simultaneously with the hind legs; only these were at first concealed beneath the skin. The formation of fore legs is similar to that of the hind legs. At first a papilla-like structure was seen to appear externally from the opercular folds, and before the end of the seventh week the tadpoles had the fore and hind legs fully formed (Pl. 1, fig. 10). During this time the tail which was long and broad began to be resorbed (Pl. 1, fig. 15). The tadpole then became more active and frequently came to the surface to breathe. At this time the gills began to degenerate and the lungs to develop and function.

The tail was fully resorbed at the eighth week and the tadpole became a young frog (Pl. 1, fig. 16). The newly transformed frog abandoned its water habitat and came to the surface by clinging to the sides of the jar and to the wire netting which covered the jar.

The changes that were observed to take place in the tadpoles are here summarized:

Incubation period—3 days
Third day after hatching
    a. Tail lengthens
    b. Appearance of external gills
    c. Appearance of mouth
    d. Alimentary canal, broad but short, appearing in the form of constricted mass at the center of the body
    e. Appearance of liver and pancreas
    f. Formation of anus

Second week after hatching
  a. Appearance of dermal folds, one on each side of head, enclosing the gills, forming the gill chambers
  b. Disappearance of external gills
  c. Formation of operculum
  d. Fusion of opercular folds to the body on the ventral surface along the right side leaving a spout-like opening on the left side
  e. Alimentary canal becoming longer and convoluted in the form of a spiral length of alimentary canal about three times that of body, excluding tail
Third week after hatching
  a. Rapid growth of the tadpoles
  b. Alimentary tract about seven times as long as body (tail excluded)
Fourth week after hatching
  a. Rapid growth of tadpoles
  b. Formation of hind and fore legs
  c. Alimentary tract, about eight times as long as body
Fifth week after hatching
  a. Appearance of rudiments of hind legs as small papillae at the junction of tail and body
  b. Papilla-like structure becoming divided into joints
  c. Alimentary tract about ten times as long as body (tail excluded)
Sixth week after hatching
  a. Hind legs fully formed
  b. Formation of lungs
  c. Rudiments of fore legs appearing as papilla-like structure
  d. Long coiled intestine about twelve times the length of the body
Seventh week after hatching
  a. Gills commenced to degenerate
  b. Fore legs fully formed
  c. Resorption of tail
  d. Alimentary tract now about three times as long as body
Eighth week after hatching
  a. Tail fully resorbed and disappeared
  b. Complete transformation of tadpole into frog
  c. Alimentary tract almost twice as long as body

c. Growth and activities of the tadpoles. Rate of growth. In determining the rate of growth of the tadpoles and the young frogs, 50 specimens were measured weekly from each of the three lots, making a total of 150 in the entire determination. Measurement was made from the tip of the snout to the tip of the tail. Soon after the tadpoles were fully transformed into young frogs, measurements were made from snout to vent.

Table 1 shows that the average measurements of the newly hatched tadpole ranged from 5 to 6 millimeters, with an average length of 5.5 millimeters. One week after hatching the tadpoles attained an average length of from 5.5 to 11.5 millimeters, or an average increase of 6 millimeters in the first week. In the second week the tadpoles increased by 8.16 millimeters, the third week by 8.67; the fourth week by 8.3. In other words, there was a steady rate of growth of the tadpoles from the period of hatching to the fourth week of their development. But in the fifth week the growth rate rapidly fell, continuing to do so to the sixth week, the increase in the fifth week being only 2.7 and in the sixth, 2.3 millimeters. In the seventh week, there was a sudden decrease in the length of the tadpoles, continuing up to the eighth week. By way of explanation, it must be repeated that resorption of the tail which began in the sixth week continued until this organ completely disappeared in the seventh and eighth weeks. At this time the transformation of the tadpoles into young frogs took place.

The type of growth of the tadpoles is shown in chart 4. The final resorption of tail, which commenced in the sixth week and ended in the eight week, is likewise indicated in that chart.

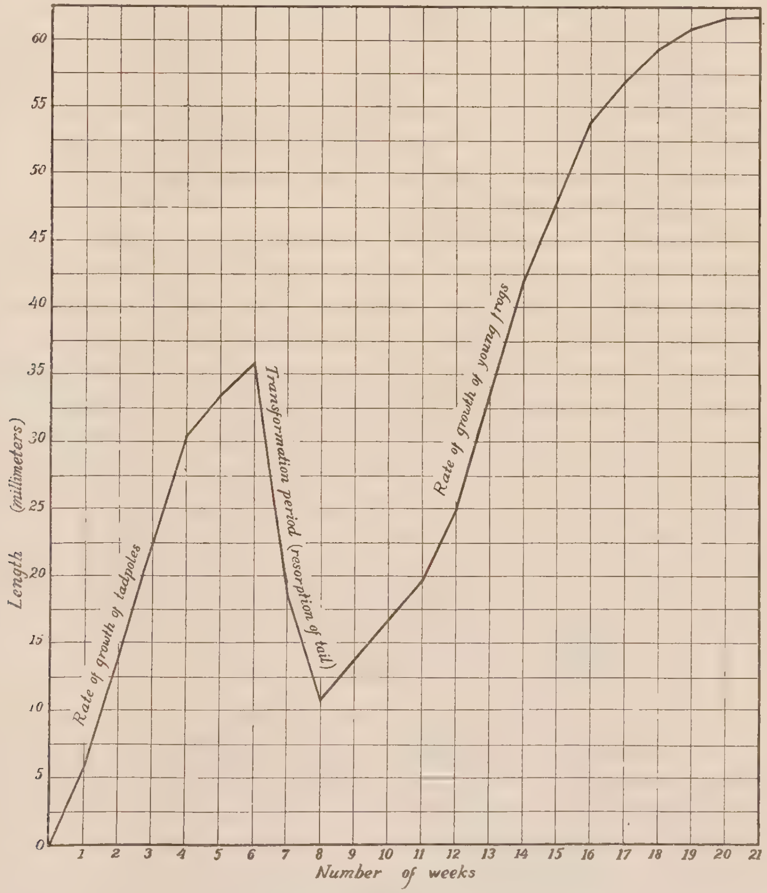

CHART 4

The growth measurements for the young frogs began in the eighth week after hatching. In the ninth week, the frogs showed an average increase in length of 3.17 millimeters; in the tenth week, 3; eleventh week, 3; twelfth week, 5.5; thirteenth week, 8.31; fourteenth week, 8.26; fifteenth week, 5.03;

sixteenth week, 6.1; seventeenth week, 2.9; eighteenth week, 3.4; nineteenth week, 1.56; twentieth week, 0.7. It is to be noted that the type of the rate of growth of the young frogs, as shown in chart 4, is similar to that of other vertebrates, of which the rates of growth have been worked out. Moderate rate of increase in length was made from the ninth to the eleventh week; the rapid rate of growth, from the eleventh to the fourteenth week, from the fifteenth week to the nineteenth, the frogs increased gradually; and from the twentieth week and later, the rate of growth was almost constant.

Manner of feeding. Obervations on the feeding habits of the tadpoles were made both under natural and artificial conditions. In the laboratory where the tadpoles where artificially reared, food consisting mainly of green algae and chopped up sweet biscuits was given once a day.

The tadpoles were voracious feeders. Twenty to thirty individuals grouped together when feeding. Larger particles of food were crushed in the mouth before swallowing. Sometimes they chased each other for the possession of a morsel of food. Mosquito larvae were also offered as food but were not eaten by the tadpoles. This further indicates that the tadpoles are exclusively vegetarian.

The intestine became longer as the tadpole grew larger. This it continued to do until the sixth week of the tadpole stage, when the entire alimentary tract was about twelve times as long as the body. A decrease in the proportionate length of the alimentary tract was noted at the end of the seventh week, at which time this organ was about three times as long as the body. When the tadpole was fully transformed into a young frog, the alimentary tract was about twice as long as the body. At this time, it was wholly carnivorous. As it approached maturity the proportion of the length of the alimentary tract to the body remained the same, that is, twice the length of the body.

In rain pools and ponds where the tadpoles developed, they were found to be gregarious, moving here and there, and eating all food within reach. The food for the most part consisted of minute organic material floating on the water, and decaying vegetable matter.

SUMMARY AND CONCLUSIONS

1. The present paper is a report on observations made on the ecology of the frogs found in Los Baños and vicinity. Ten species were studied, namely: (1) *Rana magna*, (2) *R. vittigera*, (3) *R. moodiei*, (4) *R. woodworthi*, (5) *R. similis*, (6) *Oxyglossus laevis*, (7) *Cornufer meyeri*, (8) *C. corrugatus*, (9) *Kaloula picta*, and (10) *Polypedates leucomystax*. The last named species was studied in some detail. Its postembryonic development was followed and its monthly range of food determined for one year.

2. As a result of field observations and study of extensive collections of frogs made in Los Baños, in the regions about Mount Maquiling, farms of the College of Agriculture, streams and lowlands around Los Baños, Bay, Pansol, and Calamba, and the water edge of Laguna de Bay, the ten species

of frogs studied may be grouped under the following categories in accordance with their habitats[2]:

- I. Lowland
  - (1) Found habitually in water
    - a. *Rana vittigera*
    - b. *R. moodiei*
    - c. *R. similis*
    - d. *R. woodworthi*
  - (2) Terrestrial but breeds in water
    - a. *Kaloula picta*
- II. Lowland-highland
  - (1) Found habitually in water
    - a. *Oxyglossus laevis*
  - (2) Frequent visitors to streams for breeding and feeding purposes
    - a. *Rana magna*
- III. Arboreal
  - (1) Lowland (breeds in water; primarily arboreal in feeding habits)
    - a. *Polypedates leucomystax*
  - (2) Highland
    - a. *Polypedates pardalis* (oviposits in water collected in holes of trees, and axils of plants; very rarely descends to the ground)
- IV. Woodland (breeding in forests at high altitudinal zones)
  - a. *Cornufer corrugatus*
  - b. *C. meyeri*

3. As a result of the examination of stomach contents of the frogs, the following facts relative to their feeding habits were found:

(a) Without exception, all the ten species are carnivorous and to a great extent insectivorous. The animal food constituents vary from 84.52 to 97.9 per cent; of these, the insect food constitutes from 60.6 to 83.13 per cent of the total food consumption.

(b) The amount of harmful and beneficial animals eaten by the frogs vary with different species. The approximate variations are indicated in the following figures:

SPECIES	AMOUNT OF NOXIOUS ANIMAL LIFE EATEN	AMOUNT OF BENEFICIAL ANIMAL LIFE EATEN
	per cent	*per cent*
Rana magna	50.19	41.28
R. vittigera	51.02	42.76
R. moodiei	37.30	57.50
R. woodworthi	51.75	42.25
R. similis	62.48	31.08
Oxyglossus laevis	41.74	42.78
Cornufer corrugatus	60.95	34.25
Cornufer meyeri	65.85	32.05
Kaloula picta	78.12	15.20

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[2] Referring to adults only unless otherwise stated. Findings on the nature of food constituents of the stomachs were likewise used to advantage in interpreting the ecology of the adult frogs.

(*c*) In the case of *Polypedates leucomystax*, in which the monthly range of food taken was determined during one year, the ratio of the amount of noxious to that of beneficial animals eaten by the species was 64.83 to 28.09 per cent of the annual food consumption. The largest amount of noxious animal life, mostly insect pests, were eaten by *P. leucomystax* during the period from November to January, and from May to July, two periods of the year which Uichanco (1926) has reported to be the most profitable for insect collecting in Los Baños.

4. *Rana moodiei*, *R. magna*, *R. vittigera*, and *Oxyglossus laevis* are apparently habitual visitors to fresh-water streams as evidenced by the presence in their stomachs of aquatic animals, such as snails (*Melania* spp.); shrimps (*Palaeomon lancifrons* Dana); half-beak hemiramphid (*Dermogenys viviparus* Peters); tadpoles; and fresh-water crabs (*Potamon grapsoides* Edw.). Of these species, *R. moodiei* was found to have taken the largest amount of aquatic organisms.

5. From the results of the present study of the postembryonic development, breeding habits, and rate of growth of *P. leucomystax*, the following salient points may be pointed out:

(a) The male is about two-thirds as large as the female.

(b) There appears to be no definite breeding season of the species, the frogs having been observed to breed any time when sufficient water is available for oviposition.

(c) The eggs are usually laid in a mass of foam deposited in the edge of pools or on twigs above the surface of the water. From 860 to 900 ova have been counted in a single mass of eggs laid.

(d) Eggs are fertilized by amplexation, that is, the male clasps the female firmly on the back, and while the eggs are being extruded, the sperms are shed over them.

(e) The eggs are hatched three days after laying.

(f) The mouth, external gills, gill clefts, alimentary canal, anus, liver, and pancreas appeared the first week after hatching.

(g) The formation of the opercula, disappearance of external gills, and the elongation of the alimentary canal occurred the second week after hatching.

(h) Hind and fore legs began their formation the fourth week, the former becoming fully developed at the end of the sixth week and the latter at the end of the seventh week.

(i) The changes noted in the length of the alimentary tract in relation to that of the body (tail excluded) are as follows:

Second week after hatching—three times as long as body.
Third week after hatching—seven times as long as body.
Fourth week after hatching—eight times as long as body.
Fifth week after hatching—ten times as long as body.
Sixth week after hatching—twelve times as long as body.
Seventh week after hatching—three times as long as body.
Eighth week after hatching—two times as long as body.
At this period the tadpoles are transformed into frogs.

(j) In the field and in the laboratory the tadpoles were voracious feeders. Likewise, they tended to be gregarious when feeding.

(k) The tadpoles become fully transformed into young frogs at the end of the eighth week.

(l) The frogs became sexually mature at the end of the twentieth week, during which time growth ceased.

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TABLE 1

Average weekly growth of Polypedates leucomystax

LOT 1				LOT 2			LOT 3			AVERAGE GROWTH FROM THREE LOTS
Number of weeks	Number of frogs meas-ured	Average length	Average growth	Number of frogs meas-ured	Average length	Average growth	Number of frogs meas-ured	Average length	Average growth	
		mm	*mm.*		*mm.*	*mm.*		*mm.*	*mm.*	*mm.*
Newly hatched	50	5.5	—	50	6.0	—	50	5.0	—	—
1	50	11.5	6.0	50	11.0	5.0	50	12.0	7.0	6.0
2	50	20.0	8.5	50	19.5	8.5	50	19.5	7.5	8.16
3	50	29.0	9.0	50	28.0	8.5	50	27.0	8.5	8.67
4	50	37.5	8.5	50	36.5	8.5	50	35.0	8.0	8.30
5	50	39.5	2.0	50	39.0	2.5	50	38.5	3.5	2.70
6	50	41.0	1.5	50	42.0	3.0	50	41.0	2.5	2.30
7	50	23.0[a]	18.0[a]	50	24.5[a]	17.5[a]	50	25.0[a]	16.0[a]	17.16[a]
8	50	15.5[a]	7.5[a]	50	16.0[a]	8.5[a]	50	17.0[a]	8.0[a]	8.00[a]
9	50	18.5	3.0	50	19.5	3.5	50	20.0	3.0	3.17
10	50	21.5	3.0	50	22.0	2.5	50	23.5	3.5	3.00
11	50	24.5	3.0	50	25.5	3.5	50	26.0	2.5	3.00
12	50	31.65	7.15	50	30.0	4.5	50	30.5	3.5	5.50
13	50	40.6	8.95	50	39.0	9.0	50	37.5	7.0	8.31
14	50	48.4	7.8	50	47.5	8.5	50	46.0	8.5	8.26
15	50	53.0	5.6	50	52.0	4.5	50	51.0	5.0	5.03
16	50	58.8	5.8	50	58.5	6.5	50	57.0	6.0	6.10
17	50	62.0	3.2	50	61.0	2.5	50	60.0	3.0	2.90
18	50	64.7	2.7	50	63.0	2.0	50	62.5	2.5	2.40
19	50	66.4	1.7	50	64.5	1.5	50	64.0	1.5	1.56
20	50	67.0	0.6	50	65.0	0.5	50	65.0	1.0	0.70

[a] Decrease in length due to resorption of tail

TABLE 2

Proportions of the principal items identified in the food of adult Polypedates leucomystax

KIND OF FOOD	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	YEARLY AVERAGES
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Orthoptera[1]	27.65	20.05	16.05	13.25	33.51	20.56	29.75	13.65	10.25	16.20	30.50	32.50	22.00
Coleoptera[2]	24.75	16.05	9.90	10.05	15.50	22.18	14.30	10.55	11.65	12.25	22.05	24.45	16.14
Isoptera[3]	10.05	10.75	3.55	9.85	11.76	16.55	11.00	10.25	9.50	10.35	12.15	11.50	10.61
Hymenoptera[4]	6.45	7.45	20.20	17.30	4.03	7.18	7.30	25.15	14.75	7.85	7.00	7.05	10.98
Dermaptera[5]	3.15	6.00	3.70	5.50	7.00	5.67	4.50	4.55	9.75	8.15	6.50	2.65	5.59
Odonata[6]	2.70	4.20	4.55	6.45	3.64	1.50	3.65	6.25	5.65	4.65	2.00	3.25	4.04
Lepidoptera[7]	1.35	2.15	—	—	—	3.20	2.50	1.50	2.70	2.75	2.15	—	1.52
Hemiptera[7]	4.80	3.50	6.25	—	2.00	1.45	5.50	2.45	5.20	4.30	2.45	1.40	3.28
Diptera[8]	—	—	2.40	—	1.21	1.85	2.25	—	—	1.50	1.50	0.95	0.97
Insect remains	7.00	6.30	5.50	7.30	5.00	4.00	6.00	3.85	4.00	8.25	3.00	4.25	5.37
Total insect food	87.90	76.45	72.10	69.70	83.65	84.14	86.75	78.20	73.45	76.25	89.30	88.00	80.50
Centipedes	3.55	7.05	10.05	12.05	3.15	5.75	5.40	10.95	6.25	9.05	5.00	5.25	6.95
Spiders	2.30	11.00	9.85	9.25	8.50	3.50	5.50	9.50	5.75	9.75	3.25	5.60	6.98
Earthworms	4.75	—	4.35	6.90	3.00	3.25	1.55	—	8.50	3.45	—	—	2.98
Slugs	—	3.25	2.00	—	—	1.50	—	—	2.45	—	1.35	—	0.88
Total animal food other than insects	10.60	21.30	26.25	28.20	14.65	14.00	12.45	20.45	22.95	22.24	9.60	10.85	17.79
Vegetable matter	—	1.30	1.00	1.15	0.80	1.00	—	0.90	2.25	0.95	0.70	1.15	0.93
Sand	1.50	0.95	0.65	0.95	0.90	0.86	0.80	0.45	1.35	0.55	0.40	—	0.78
Total vegetable and inorganic matter	1.50	2.25	1.65	2.10	1.70	1.86	0.80	1.35	3.60	1.50	1.10	1.15	1.71

[1] Grasshoppers, crickets, cockroaches, green locust.

[2] Cassididae, Cerambycidae, Coccinellid beetles, Anthribidae, Scarabaeidae, Chrysomelidae, Tenebrionidae.

[3] Termites (Termitidae).

[4] Ants (Formicidae).

[5] Earwigs (Dermaptera).

[6] Dragonflies.

[7] Larvae of banana leaf roller (Hesperiidae).
Green soldier bug (Pentatomidae), Oriental cotton stainer (Pyrrhocoridae)

[8] Common housefly (Muscidae).

TABLE 3

Monthly range of stomach contents of frogs of Polypedates leucomystax

KIND OF FOOD		JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE	
Order	Family or common name	Injurious	Beneficial	Injurious	Beneficial	Injurious	Beneficial	Injurious	Beneficial	Injurious	Beneficial	Injurious	Beneficial
		per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Orthoptera...	Locustidae.....	15.00	—	7.30	—	6.80	—	8.75	—	15.75	—	10.26	—
	Gryllidae......	7.65	—	8.75	—	7.15	—	4.50	—	12.90	—	7.35	—
	Blattidae......	3.00	—	4.00	—	2.10	—	—	—	—	—	—	—
	Tettigoniidae...	2.00	—	—	—	—	—	—	—	4.86	—	2.95	—
Coleoptera...	Cassididae.....	3.90	—	3.20	—	1.90	—	—	—	3.20	—	3.40	—
	Chrysomelidae.	6.45	—	2.50	—	2.25	—	3.15	—	4.10	—	2.30	—
	Cerambycidae..	5.65	—	4.25	—	2.75	—	2.35	—	2.75	—	6.25	—
	Tenebrionidae..	2.15	—	—	—	1.35	—	—	—	—	—	3.18	—
	Anthribidae....	1.85	—	3.35	—	—	—	—	—	1.70	—	—	—
	Scarabaeidae...	1.50	—	—	—	1.65	—	2.75	—	1.60	—	5.10	—
	Coccinellidae...	—	3.25	—	2.75	—	—	—	1.80	—	2.15	—	1.95
Isoptera.....	Termitidae.....	10.05	—	10.75	—	3.35	—	9.85	—	11.76	—	16.55	—
Hymenoptera	Formicidae....	6.45	—	7.45	—	20.20	—	17.30	—	4.03	—	7.18	—
Dermaptera..	Forficulidae....	—	3.15	—	6.00	—	3.70	—	5.50	—	7.00	—	5.67
Odonata.....	Dragonfly.....	—	2.70	—	4.20	—	4.55	—	6.45	—	3.64	—	1.50
Lepidoptera..	Hesperidae.....	1.35	—	2.15	—	—	—	—	—	—	—	3.20	—
Hemiptera...	Pentatomidae.	2.60	—	—	—	2.80	—	—	—	—	—	1.45	—
Hemiptera...	Pyrrhocoridae..	2.20	—	3.50	—	3.45	—	—	—	2.00	—	—	—
Diptera.....	Muscoidea.....	—	—	—	—	2.40	—	—	—	1.21	—	1.85	—
	Centipedes.....	—	3.55	—	7.05	—	10.05	—	12.05	—	3.15	—	5.75
	Spiders........	—	2.30	—	11.00	—	9.85	—	9.25	—	8.50	—	3.50
	Earthworm....	—	4.75	—	—	—	4.35	—	6.90	—	3.00	—	3.25
	Slugs..........	—	—	3.25	—	2.00	—	—	—	—	—	1.50	—
Total.......	—	71.80	19.70	60.45	31.00	60.35	32.50	48.65	41.95	65.86	27.44	72.50	21.62

TABLE 3—(Continued)

KIND OF FOOD		JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER		YEARLY AVERAGES	
Order	Family or common name	Injurious	Beneficial	Injurious	Beneficial	Injurious	Beneficial	Injurious	Beneficial	Injurious	Beneficial	Injurious	Beneficial	Injurious	Beneficial
		per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Orthoptera...	Locustidae.....	16.30	—	8.75	—	5.65	—	9.75	—	14.15	—	15.75	—	11.46	—
	Gryllidae......	13.45	—	4.90	—	4.60	—	6.45	—	9.65	—	10.40	—	8.06	—
	Blattidae......	—	—	—	—	—	—	—	—	—	—	—	—	0.75	—
	Tettigoniidae...	—	—	—	—	—	—	—	—	6.70	—	6.35	—	1.81	—
Coleoptera...	Cassididae.....	3.00	—	—	—	—	—	—	—	2.15	—	3.40	—	2.01	—
	Chrysomelidae.	3.25	—	2.45	—	3.15	—	4.20	—	7.30	—	8.15	—	4.08	—
	Cerambycidae..	6.15	—	3.65	—	3.50	—	5.15	—	4.20	—	7.70	—	4.54	—
	Tenebrionidae..	—	—	—	—	2.30	—	—	—	—	—	—	—	0.75	—
	Anthribidae....	—	—	—	—	—	—	—	—	—	—	—	—	0.58	—
	Scarabaeidae...	1.90	—	3.30	—	2.70	—	2.90	—	4.80	—	3.65	—	2.66	—
	Coccinellidae...	—	—	—	1.15	—	—	—	—	—	3.60	—	1.55	—	1.52
Isoptera.....	Termitidae.....	11.00	—	10.25	—	9.50	—	10.35	—	12.15	—	11.50	—	10.61	—
Hymenoptera	Formicidae....	7.30	—	25.15	—	14.75	—	7.85	—	7.00	—	7.05	—	10.86	—
Dermaptera..	Forficulidae....	—	4.50	—	4.55	—	9.75	—	8.15	—	6.50	—	2.65	—	5.59
Odonata.....	Dragonfly.....	—	3.65	—	6.25	—	5.65	—	4.65	—	2.00	—	3.25	—	4.07
Lepidoptera..	Hesperidae.....	2.50	—	1.50	—	2.70	—	2.75	—	2.15	—	—	—	1.53	—
Hemiptera...	Pentatomidae..	1.50	—	—	—	1.60	—	1.40	—	—	—	—	—	0.95	—
Hemiptera...	Pyrrhocoridae..	4.00	—	2.45	—	3.60	—	1.90	—	2.45	—	1.40	—	2.33	—
Diptera.....	Muscoidea.....	2.25	—	—	—	—	—	1.50	—	1.50	—	0.95	—	0.97	—
	Centipedes.....	—	5.40	—	10.95	—	6.25	—	9.05	—	5.00	—	5.25	—	6.95
	Spiders........	—	5.50	—	9.50	—	5.75	—	9.75	—	3.25	—	5.60	—	6.98
	Earthworm....	—	1.55	—	—	—	8.50	—	3.45	—	—	—	—	—	2.98
	Slugs..........	—	—	—	—	2.45	—	—	—	1.35	—	—	—	0.88	—
Total......	—	72.60	20.60	62.40	32.40	56 50	35.90	55 20	35.05	75.55	20.35	76.30	18.30	64.83	28.09

NOTE:
Insect fragments—5.37 } Not included.
Vegetable and inorganic materials—1.71

TABLE 4

Stomach contents of tadpoles of Polypedates leucomystax based upon examination of 232 frogs

KIND OF FOOD	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	YEARLY AVERAGES
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Termites	40.0	28.0	4.5	15.00	38.00	70.00	67.00	42.00	11.00	23.00	37.50	33.0	34.08
Ants	35.5	42.0	46.0	40.00	29.00	11.00	15.00	37.00	57.00	48.00	29.00	42.0	35.96
Crickets	5.5	7.5	15.0	9.50	10.00	7.00	12.00	5.00	12.00	17.00	15.00	9.0	10.38
Grasshoppers	10.0	13.5	27.0	28.20	20.00	12.00	3.50	11.00	14.00	8.00	17.00	15.0	14.93
Flies	2.0	—	1.5	3.75	—	—	—	—	1.90	—	—	—	0.76
Spiders	4.5	7.5	6.0	2.60	1.50	—	2.50	5.00	3.10	2.00	1.50	1.0	3.10
Vegetable debris and sand	2.5	1.5	—	0.95	1.50	—	—	—	1.00	2.00	—	—	0.79
Total	100.00	100.00	100 00	100 00	100.00	100.00	100.00	100.00	100 00	100 00	100 00	100 00	100.00

TABLE 5

Stomach contents of ten species of frogs collected at random at Los Baños and vicinity

KIND OF FOOD		RANA MAGNA		RANA VITTIGERA		RANA MOODIEI		RANA WOODWORTHI		RANA SIMILIS	
Order	Family or common name	Injurious	Beneficial	Injurious	Beneficial	Injurious	Beneficial	Injurious	Beneficial	Injurious	Beneficial
		per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Orthoptera	Locustidae	16.0	—	17.0	—	9.60	—	18.0	—	7.20	—
	Gryllidae	8.5	—	12.73	—	6.60	—	10.0	—	6.40	—
	Tettigoniidae	4.0	—	—	—	—	—	5.0	—	—	—
	Blattidae	—	—	—	—	—	—	—	—	—	—
Coleoptera	Cassididae	2.7	—	0.75	—	—	—	—	—	—	—
	Cerambycidae	0.7	—	—	—	—	—	—	—	—	—
	Coccinellidae	—	1.5	—	1.8	—	—	—	—	—	—
	Chrysomelidae	0.7	—	—	—	—	—	—	—	1.90	—
	Haliplidae	—	0.8	—	2.58	—	3.8	—	—	—	1.90
	Hydrophilidae	—	7.3	—	5.37	—	3.8	—	—	—	8.68
	Scarabaeidae	1.8	—	—	—	—	2.5	—	—	—	—
	Tenebrionidae	—	—	1.05	—	—	—	2.0	—	—	—
	Anthribidae	—	—	—	—	—	—	—	—	—	—
Isoptera	Termitidae	11.76	—	7.18	—	7.30	—	6.75	—	29.76	—
Dermaptera	Forficulidae	—	7.0	—	7.18	—	—	—	11.75	—	—
Hymenoptera	Formicidae	4.03	—	5.67	—	11.00	—	4.00	—	10.12	—
Odonata	Dragonflies	—	8.17	—	0.36	—	3.80	—	9.00	—	4.80
Diptera	Muscidae	—	—	1.91	—	—	—	—	—	2.10	—
Hemiptera	Water bugs	—	—	—	0.60	—	2.90	—	—	—	—
Lepidoptera	Caterpillar	—	—	3.27	—	2.80	—	2.00	—	5.0	—
Hemiptera	Bugs	—	—	—	—	—	—	—	—	—	—
	Spiders	—	8.34	—	12.09	—	9.30	—	10.00	—	8.60
	Centipedes	—	3.16	—	4.00	—	2.30	—	5.00	—	6.50
	Crabs	—	—	—	1.81	—	22.00	—	—	—	—
	Shrimps	—	0.67	—	0.91	—	2.80	—	—	—	—
	Fish	—	1.67	—	1.64	—	1.90	—	—	—	—
	Tadpole	—	1.17	—	—	—	—	—	—	—	0.60
	Snails	—	1.50	—	0.96	—	0.90	—	2.00	—	—
	Earthworm	—	—	—	3.46	—	—	—	4.5	—	—
	Slugs	—	—	1.46	—	—	—	1.50	—	—	—
	Typlop sp.	—	—	—	—	—	—	—	—	—	—
Total	—	50.19	41.28	51.02	42.76	37.3	57.50	51.75	42.25	62.48	31.08

TABLE 5—(Continued)

KIND OF FOOD						CORNUFER MEYERI		POLYPEDATES LEUCOMYSTAX		KALAULA PICTA	
Order	Family or common name	Injurious	Beneficial	Injurious	Beneficial	Injurious	Beneficial	Injurious	Beneficial	Injurious	Beneficial
		per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Orthoptera...	Locustidae.....	11.35	—	—	—	—	—	11.46	—	0.80	—
	Gryllidae......	5.43	—	—	—	—	—	8.06	—	5.00	—
	Tettigoniidae...	—	—	—	—	—	—	1.81	—	—	—
	Blattidae......	—	—	—	—	—	—	0.75	—	3.56	—
Coleoptera...	Cassididae.....	—	—	—	—	—	—	2.01	—	—	—
	Cerambycidae..	—	—	—	—	—	—	4.54	—	—	—
	Coccinellidae...	—	0.50	—	—	—	—	—	1.52	—	—
	Chrysomelidae.	—	—	—	—	—	—	4.08	—	—	—
	Haliplidae.....	—	5.85	—	—	—	—	—	—	—	—
	Hydrophilidae..	—	3.40	—	—	—	—	—	—	—	—
	Scarabaeidae...	1.45	—	—	—	—	—	2.66	—	0.20	—
	Tenebrionidae..	0.50	—	5.00	—	7.50	—	0.75	—	0.60	—
	Anthribidae....	0.65	—	4.95	—	6.25	—	0.58	—	7.00	—
Isoptera.....	Termitidae.....	8.95	—	26.0	—	31.50	—	10.61	—	37.50	—
Dermaptera..	Forficulidae....	—	10.48	—	7.50	—	8.00	—	5.59	—	—
Hymenoptera	Formicidae....	11.46	—	25.0	—	20.60	—	10.86	—	22.06	—
Odonata.....	Dragonflies....	—	2.15	—	5.25	—	7.00	—	4.07	—	5.0
Diptera.....	Muscidae......	0.50	—	—	—	—	—	0.97	—	1.40	—
Hemiptera...	Water bugs....	—	1.20	—	—	—	—	—	—	—	—
Lepidoptera..	Caterpillar.....	0.60	—	—	—	—	—	1.53	—	—	—
Hemiptera...	Bugs..........	0.85	—	—	—	—	—	3.28	—	—	—
	Spiders........	—	11.80	—	8.50	—	7.05	—	6.98	—	6.60
	Centipedes.....	—	0.70	—	13.00	—	10.00	—	6.95	—	3.60
	Crabs.........	—	0.70	—	—	—	—	—	—	—	—
	Shrimps.......	—	3.45	—	—	—	—	—	—	—	—
	Fish..........	—	—	—	—	—	—	—	—	—	—
	Tadpole.......	—	0.90	—	—	—	—	—	—	—	—
	Smails........	—	1.65	—	—	—	—	—	—	—	—
	Earthworm....	—	—	—	—	—	—	—	2.98	—	—
	Slug..........	—	—	—	—	—	—	—	—	—	—
	Typlops sp....	—	—	—	—	—	—	1.88	—	—	—
Total.......	———	41.74	42.78	60.95	34.25	65.85	32.05	64.83	28.09	78.12	15.20

Note:

Insect fragments
Vegetable and mineral matter } — not included.

EXPLANATION OF PLATE 1

(Drawings by Daniel Buñag. Magnifications indicated refer to original drawings)

Fig. 1. Freshly laid egg, ×24
2. Twenty-four-hour egg, ×24
3. Newly hatched tadpole, ×20
4. Three-day tadpole, ×20
5. Five-day tadpole, ×20
6. One-week tadpole, ×20
7. Three-week tadpole, ×15
8. Five-week tadpole, showing papilla-like structure at the junction of tail and body, ×15
9. Six-week tadpole, showing fully formed hind legs, ×10
10. Seven-week tadpole, showing hind and fore legs already formed, ×10
11. One-week tadpole, dissected to show intestine, ×20
12. Two-week tadpole, dissected to show increasing length of intestines, ×12
13. Six-week tadpole, dissected to show the much coiled intestine, ×6
14. Seven-week tadpole dissected to show decrease in length of alimentary canal, ×6
15. Seven-week tadpole showing resorption of tail, ×6
16. Newly emerged frog (tail fully resorbed), ×6
17. Nine-week frog, ×3
18. Male and female in amplexation, ×2

Villadolid and del Rosario: Polypedates leucomystax] [Phil. Agriculturist, Vol. XVIII No. 8

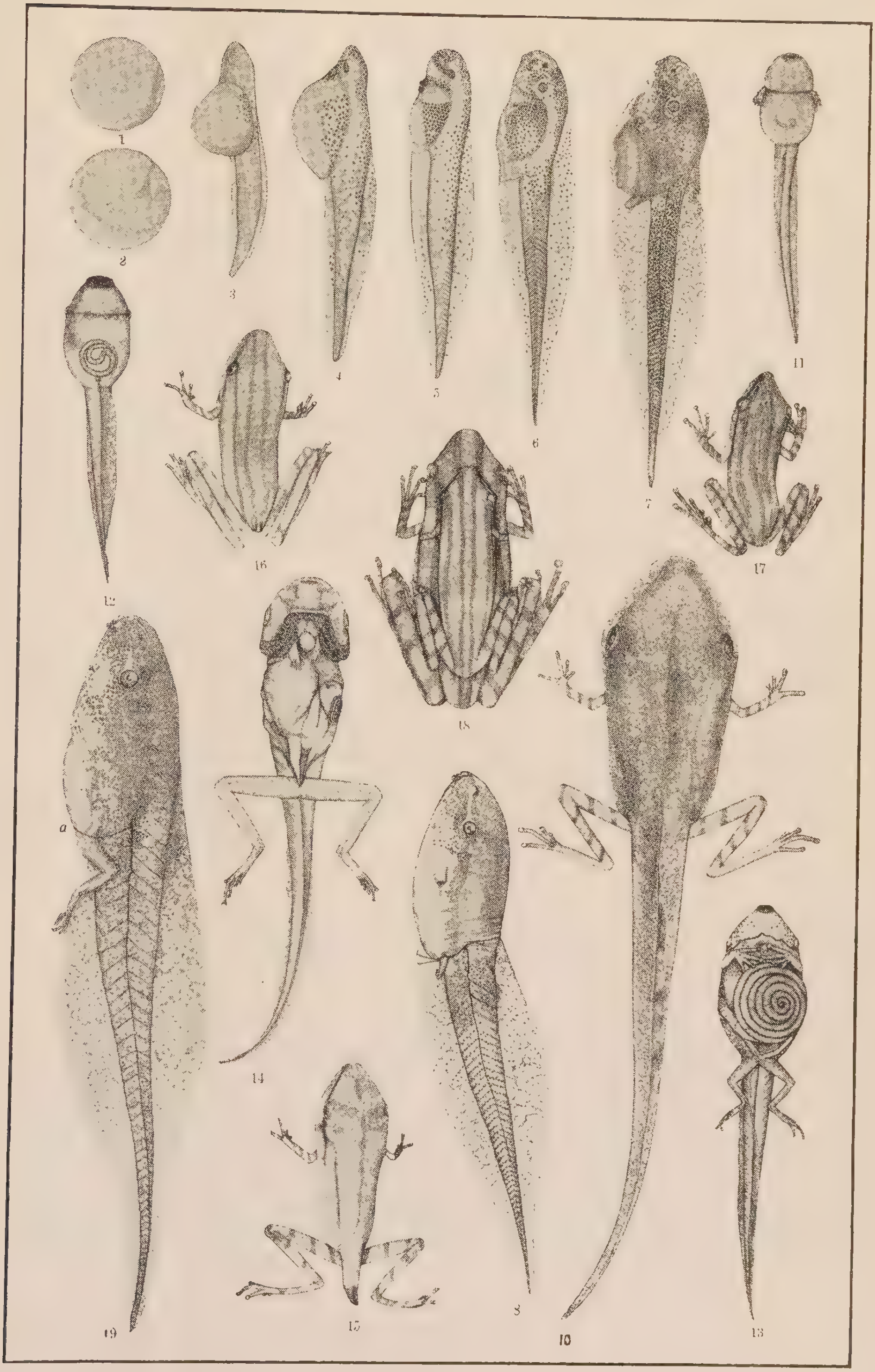

PLATE 1

AN AVIAN DISEASE NEW TO THE PHILIPPINES

A. K. GOMEZ

Of the College of Veterinary Science

WITH FIVE TEXT FIGURES

From September to December, 1927, and during January and February, 1928, a severe epizoötic of fowls was registered in Manila and the neighboring towns in the provinces of Bulacan, Rizal, and Laguna. Probably about 5,000 fowls have died of this malady within a period of six months. Two recorded instances show that out of 350 cases in a poultry yard in San Pedro Tunasan, 334 deaths occurred, and out of 181 cases in Biñang, there were 168 deaths. The disease recurred at about the same time in 1928 and 1929 with the same virulence as at first. It seems to be of recent introduction, as no record is known of its previous occurrence in the Philippines. The disease is similar to the one described in England by Doyle (1927) which he called "Newcastle disease," because it occurred in Newcastle-on-Tyne.

PERIOD OF INCUBATION

In the present work the period of incubation in experimental infection was found to vary from 4 to 6 days, or an average of 5 days. In birds that contracted the disease through cohabitation the period of incubation might be prolonged to 8 days.

Natural infection is accomplished by way of the digestive tract from contaminated food and water infected with saliva of sick birds. The feces do not contain the virus of the disease; when mixed with the food and water, they do not transmit the infection to healthy fowls.

ETIOLOGY

The cause of this disease is a filtrable virus. The following experiments, out of thirty-three, demonstrated the character of its causative agent:

On January 21, 1928, one black hen (field case), which had died an hour previously, and two white pullets showing acute symptoms were brought to the College of Veterinary Science for diagnosis. The dead bird showed typical lesions of the disease upon autopsy. Two agar and two bouillon tubes were inoculated with blood from the heart, the liver, and the spleen. Smears from these same organs were made, stained with Loeffler's methylene blue and examined under the microscope. They did not reveal the presence of either *Pasteurella avicida* (fowl cholera) or of *Salmonella gallinarium* (fowl typhoid).

Blood from the sick birds was drawn under aseptic conditions from the radial vein and diluted with equal volume of sterile salt solution. One mil of this diluted blood was inoculated intramuscularly into two healthy chickens. These blood inoculations proved ineffective in transmitting the disease. However, chicken E1, fed with pieces of infective duodenum and liver on January 21, 1928, contracted the disease and died 10 days after infection. A piece of the duodenum of this chicken was washed with salt solution and triturated in a sterile mortar and pestle. Fifty mils of salt solution were added and the emulsion was passed through a layer of cotton and then filtered through a Berkefeld candle. Filtration did not take more than 20 to 30 minutes. The filter was operated by means of a Chapman aspirator connected to a water faucet. Sterility test of the filtrate was made by transferring one mil of it into bouillon tubes and incubating this for at least five days. At the same time, two mils of the filtrate were inoculated intramuscularly into a native pullet No. E4.

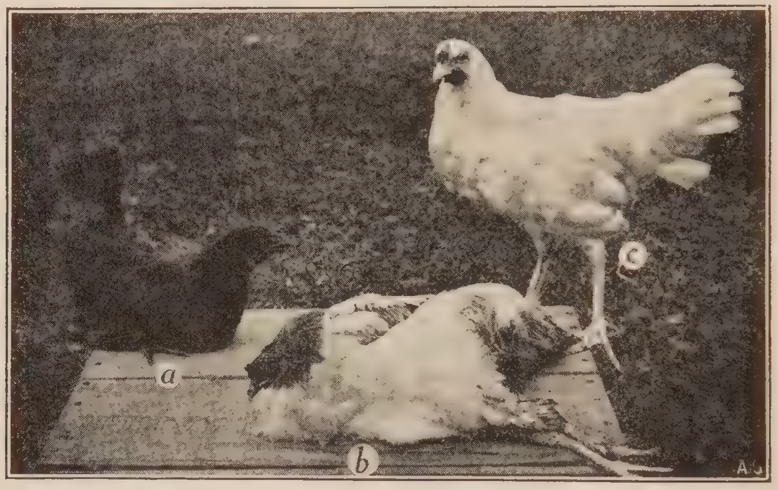

Fig. 1.—Three Stages in the Progress of the Disease.

a. Experimental bird showing acute symptoms. *b.* Field case showing paralysis of the bird. *c.* Period of incubation in experimental bird one day before symptoms appeared.

Chicken E4 was found dead on February 6, six days after inoculation with the filtrate, without showing pronounced symptoms of the disease. Autopsy findings, however, showed typical lesions. A piece of the oesophagus, which, in this case, showed marked congestion and hemorrhages, was triturated by the use of a sterile mortar and pestle, emulsified in fifty mils of salt solution, then passed through a layer of cotton, and finally filtered through a Berkefeld candle. One mil of the filtrate was inoculated intramuscularly into Cantonese pullet No. E8. A piece of the duodenum was also taken and similarly treated. One mil of the filtrate was then inoculated into Cantonese pullet No. E9.

Chicken E8 became sick, six days after inoculation. It recovered, but remained in an unthrifty condition for a long time.

Chicken E9 was sick on February 10, with the following symptoms: eyes closed, inappetence, frequent gasping for air, very weak. Blood count showed 2,250,000 red blood cells and 11,880 white blood cells per cubic millimeter of blood. On February 13, it was found dead, seven days after inoculation. Autopsy showed hemorrhagic duodenitis, hemorrhages on the surface of the gizzard, and congestion of the oesophagus. The duodenum of this chicken was again emulsified and passed through a Berkefeld filter. Two mils of the filtrate were inoculated intraperitoneally into a guinea pig and one mil into a white rat, also intraperitoneally. A piece of the same duodenum was fed to another white rat. None of these animals contracted the disease.

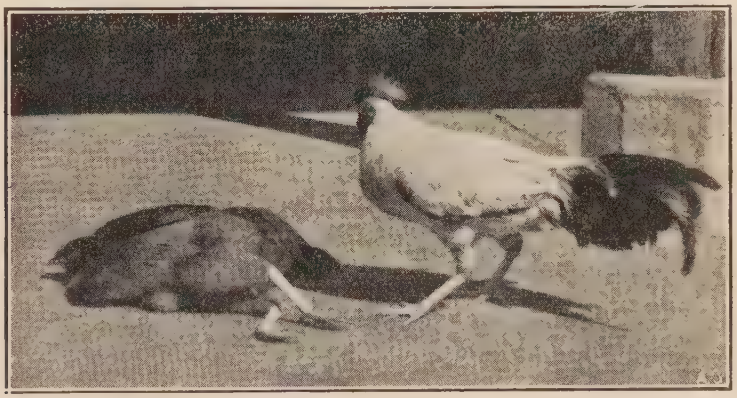

Fig. 2.—Field Cases Showing Weakness and Paralysis of the Legs.

In another series of experiments, it was demonstrated that the saliva and the contents of the crop of sick birds were highly infective, even after passing through a Berkefeld candle.

Transmission of the disease to a duck was also tried. A duck was inoculated intramuscularly with 4 mils of duodenal filtrate from sick chicken No. 10 on February 22, 1928. This duck contracted the disease and died in five days.

Two pigeons were also used. One was inoculated intramuscularly with one mil of duodenal filtrate. It did not contract the disease. The other was successfully infected with the saliva of sick bird No. 26, by mixing it with the drinking water on March 15. Six days later this pigeon showed marked symptoms of paralysis. The eyes were partly closed, head wobbly and carried backwards, and the movements incoordinate. There was a copious slimy mucous discharge in the mouth cavity. It died March 23, eight days after infection. Autopsy lesions were typical of the disease.

SYMPTOMS

The first symptom of the disease is that of inappetence. The sick bird will not eat and is left behind by the rest of the flock. It soon becomes weak and crouches in a corner of the cage with half-closed eyes and open beak (fig. 1a). There may be a slight increase of body temperature, sometimes reaching 43° C. The fever curve is irregular and a sudden decrease to below the normal may occur just before death (fig. 2). The feathers are ruffled and a marked dopiness is frequently observed. Gasping for air and frequent swallowing movements due to the slimy mucus in the nasal passage, throat, and oesophagus, are the most common symptoms in the acute form of the disease. A watery, fetid diarrhea soon sets in, the discharges soiling the posterior parts of the fowl particularly in cases that show paralysis of the legs (figs. 1 and 2). The crop is distended with gas and a brownish, ill-smelling liquid content. In resistant birds the disease runs a protracted course. The sick bird becomes weak in the legs and in the majority of these cases a permanent paralysis of one or both legs results (figs. 1a and 2). These paralyzed birds die from inanition due to their inability to move about and obtain food. A recovered but paralyzed hen was kept alive for three months by proper feeding and would have lived longer had she been permitted. Paralysis of the wings may also be noticed (fig. 3a) and in one experimental case a complete paralysis of all the muscles of the body was observed (fig. 3b). This bird lived for several days in this condition and died of inanition.

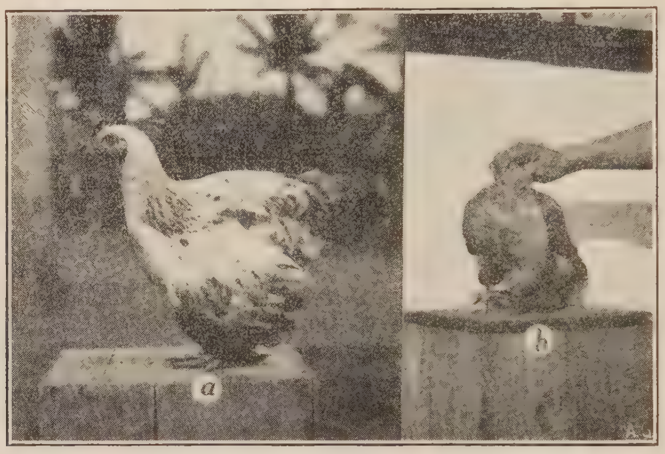

Fig. 3.—Paralysis in Diseased Experimental Birds.
a. Paralysis of the wings. *b.* Paralysis of all the muscles of the body.

The course of the disease is very short in the acute form. After the symptoms appear, death occurs in 2 to 3 days. In resistant birds, the symptoms are not pronounced. Recovery frequently takes place in these cases, but a complete paralysis of one or both legs often persists. The paralysis in the early stage appears to be limited to the motor nerves as the bird feels the pain inflicted by a pin prick or a sharp blow, but is not able to retract the legs. Soon, however, all sensation is lost and the muscles of the legs become atrophied.

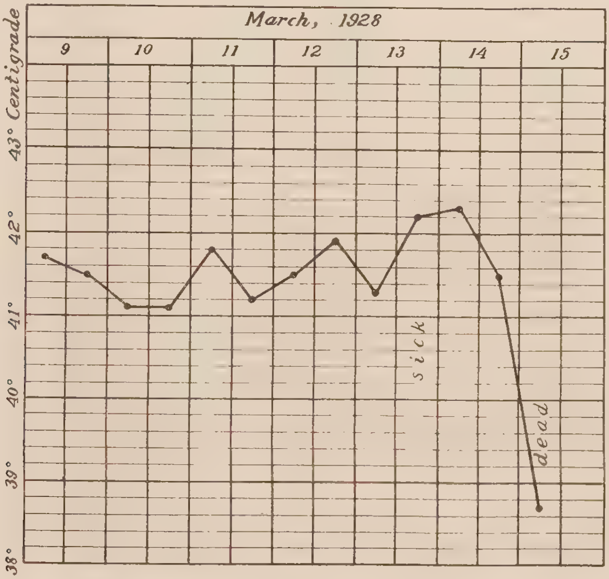

Fig. 4.—Temperature curve of chicken No. E26 from time of infection to the termination of the disease, after feeding with a piece of duodenum of a field case showing paralysis of legs.

MORBID ANATOMY

The dead bird in some cases shows a thick slimy mucus on the beak, in the nasal passages, and the pharynx. The posterior part of the carcass may be soiled with a watery, fetid, fecal discharge. The comb and wattles may or may not be cyanotic. On opening the abdominal cavity, hemorrhages are frequently seen on the surface of the gizzard and proventriculus. The duodenal mucous membrane is in most cases either markedly congested or hemorrhagic and the intestinal content may be admixed with blood. Occasionally the hemorrhagic inflammation may extend throughout the digestive tract. The glandular surface of the proventriculus may also show a few petechiae. Microscopical examination of sections of the duodenum shows the mucosa to be greatly thickened and its surface desquamated. Goblet cells are numerous and prominent. The intestinal glands in some places have disappeared and in their places areas of cellular infiltration may be seen. The capillaries of the villi are engorged with red cells which in some spots are placed extravascularly, as evidence of hemorrhages. The submucosa shows slight serous infiltration, and the muscular coat a marked distention of the blood vessels with red cells. The liver, spleen, and kidneys show no visible changes except a marked reddening of their parenchyma. Histological sections of these organs reveal an engorgement of the blood vessels which is particularly pronounced in the liver. The hepatic cells show indistinct outline and granular protoplasm. The lungs may be congested or edematous. In some cases there is a serous infiltration and hemorrhagic extravasation in the connective tissue surrounding the oesophagus and crop. This organ is distended with gas and brownish, fermented liquid content. Excoriation of the epithelium of the pharynx and oesophagus was observed in one case, giving it the appearance of being sprinkled with bran.

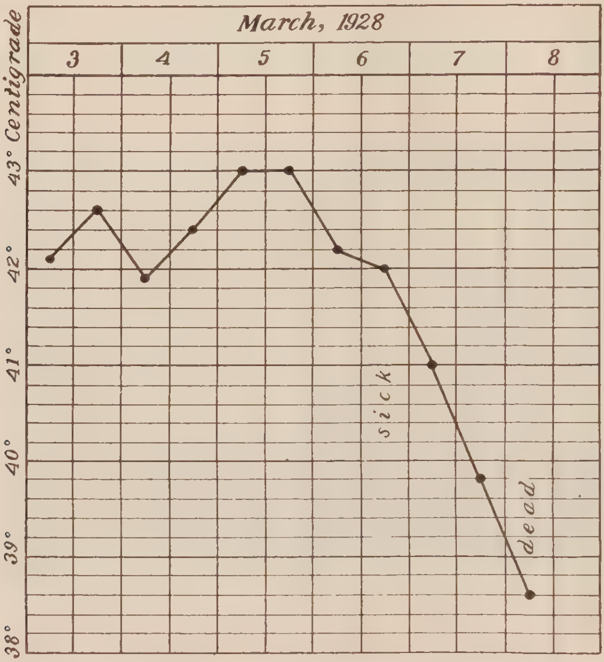

Fig. 5.—Temperature curve of chicken No. E8 from time of infection to termination of the disease after feeding with saliva and crop content of sick bird (experimental) No. E12. *Errata:* Transfer "sick" from column March 6, p. m., to column March 5, a. m.

DISCUSSION

That the disease herein reported is neither fowl cholera nor fowl typhoid is established by the fact that the organisms causing these diseases were not found in the organs or tissues of either field cases or experimental ones. Furthermore, the filtrability of the virus was demonstrated repeatedly by transmission experiments of filtrates of the duodenal emulsion of sick birds to healthy ones. The new disease can be distinguished from fowl plague, which is also caused by a filterable virus, because in the latter the blood is highly infective, whereas attempts at blood inoculation of the former most often failed. Moreover, pigeons are resistant to the virus of fowl plague, while the present disease infects them. The saliva and the crop contents, on the other hand, were shown to be highly infective and there is no doubt that natural infection is obtained from food and water contaminated from these sources. The disease is not transmissible to mammals.

SUMMARY AND CONCLUSIONS

1. An infectious disease of fowls new to the Philippines is herein reported.
2. The cause of this disease is a filtrable virus.
3. Its symptoms are inappetence, marked dopiness, irregular temperature, gasping for air, mucous discharge from the nasal passages and mouth, diarrhoea, and in resistant birds paralysis of the legs.
4. The course of the disease is short, death taking place soon after acute symptoms appear.
5. This malady resembles "Newcastle disease," an avian pest reported in England by Doyle in 1927.

ACKNOWLEDGEMENT

The writer wishes to express his gratitude to Dr. F. M. Fronda for his coöperation in supplying most of the experimental chickens, and to Dr. Vicente Diaz for the field cases brought to the laboratory for study.

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AN ANNOUNCEMENT: THE U. P. RURAL HIGH SCHOOL

PURPOSE

The University of the Philippines Rural High School was established in June, 1929, as a subsidiary of the Department of Agricultural Education of the College of Agriculture. It is intended to serve as a practice school for the training of teachers of agriculture, as a field for the study of problems in agricultural education, to train intermediate school graduates in agriculture, and to prepare them for advanced education.

ADMISSION REQUIREMENTS

Applicants for admission must be graduates of an approved intermediate school, and, upon matriculation, present identification cards showing an average grade of 75 per cent or above in English subjects and arithmetic.

No tuition fee is charged in the U. P. Rural High School. The following incidental fees of the College of Agriculture are collected from high-school students at the time of matriculation: Library fee—₱5; athletic fee—₱3; medical fee—₱4; U. P. Rural High School student body fee—₱0.40. All fees are for the entire year; no students are matriculated at the beginning of the second semester. A general deposit of ₱15 is also required.

Entire self-support is practically impossible for Rural High School students. The estimated expenses are ₱50 at entry and ₱10 a month.

COURSE OF STUDY

The work of the U. P. Rural High School is on the same basis as the regular rural high schools under the Bureau of Education, but with certain modifications in order to meet the needs of students leaving before graduation, of prospective teachers, and of those pupils who expect to go beyond the high school.

FIRST YEAR	SECOND YEAR	THIRD YEAR	FOURTH YEAR
Literature (4) Current Events (1)	Literature and Composition (4) Current Events (1)	Literature and Composition (4) Current Events (1)[a]	Literature and Composition (4)[b] Current Events (1)[a]
Composition (5)	General Science (5) Biology (5)	General History (5)	History (5)[b]
Algebra (5)	Geometry (5)	Avanced Algebra (5) Arithmetic and Farm Accounting (5)	Physics (5)[b]
Horticulture (5)	Animal Husbandry (5)	Major Farm Crops (5)	Elective (5)[b]

Field work: 3 hours a day, 5 days a week, during the academic sessions; and 6 hours a day, 5 days a week, during academic vacations. Vacation furloughs total 4 to 8 weeks.[c]

Physical Education and group games for all students.

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[a] By faculty arrangement Current Events may be included with History.

[b] The fourth year is not offered during the school year 1930-1931. Details of the work for this year will be announced later.

[c] The length of a student's furlough depends upon the quality of his academic and field work. At present the girls are not required to attend school during academic vacations.

It is expected that regular work will be offered in first, second, and third year secondary for the school year 1930-1931.

Applications for admission may be filed at any time, but no admissions can be approved before May 1, 1930. The number of applicants who can be admitted is very definitely limited. Students poor in scholarship are not permitted to remain in the school.

Four additional teachers have been approved for the U. P. Rural High School and it is planned to increase the present enrollment to about 300 next June, largely through the addition of two sections in second year and one section in third year.

OFFICERS OF ADMINISTRATION

Dean, College of Agriculture: DR. BIENVENIDO M. GONZALEZ
Head, Department of Agricultural Education: PROF. MERLE A. FOSTER
Acting Principal: ASST. PROF. NENA HELEN FOSTER
Acting Field Manager: PAULINO E. COSTA
Clerk: GREGORIO GOCO

FACULTY OF INSTRUCTION

NENA HELEN FOSTER, A.B.
  Assistant Professor of Agricultural Education, Acting Principal
PAULINO E. COSTA, B.S.A.,
  Instructor in Horticulture and Science, Acting Field Manager
FELIPE O. CEVALLOS, B. AGR., M.S.A., Ph. D.
  Teacher on detail by Bureau of Education
HAZEL D. REED, A.B.
  Instructor in English
NICANOR M. CASTILLO, B. AGR., B.S.A.
  Teacher in Mathematics
SISENANDO REANTASO, B. AGR.
  Teacher in Animal Husbandry
PASCUAL ROBIN, B. AGR.
  Teacher in Horticulture

COLLEGE AND ALUMNI NOTES

Dr. Richard Goldschmidt, director of the Kaiser Wilhelm Institut für Biologie, Berlin, Germany, gave a lecture in the College Auditorium on December 9 on the physiology of sex determination, under the auspices of the Los Baños Biological Club. The lecture was followed by a luncheon at the Molawin Hall. President Palma honored both functions with his presence.

* * *

Major General and Mrs. Paul B. Malone, commanding general of the Philippine Division, U. S. Army, and party visited the College on December 5. The visitors were escorted to the different laboratories and field cultures by Chief Clerk Yñiguez. The General was greatly interested in the various phases of the work of the College.

* * *

In the last delinquency report, issued by the Secretary of the College of Agriculture on December 17, there were delinquent, 91 students; probation, 29; extreme delinquent, 16. On the other hand, 97 students who had been on the delinquency list in the September report have since improved their scholarship records and have been restored to regular standing.

* * *

Dr. N. Bach, a prominent sugar planter of Capiz, was at the College on December 17 in order to secure cassava cuttings for planting in his hacienda. He was furnished seventeen varieties, all of which had been introduced by Doctor Mendiola from Java in 1927.

* * *

Mr. Severo M. Capistrano, '15, of the Bureau of Agriculture, has been another campus visitor. Mr. Capistrano is a recent arrival from the United States where he took up advanced work in agricultural engineering at the Iowa State College of Agriculture and Mechanic Arts.

* * *

Letters received by friends at the College from Prof. Emma S. Yule, professor of English and head of the English Department, speak of the delightful time she has been having in revisiting familiar scenes of earlier days and meeting old friends and other interesting people in various parts of the United States, after her arrival there in October from Europe. She may be reached in care of Grant Hotel, 127 North El Molino Avenue, Pasadena, California, up to the end of January. Professor Yule was until recently editor of the *Philippine Agriculturist.*

The Cine Maquiling Company gave a complimentary moving-picture show at the College Auditorium on December 31. Admission was free to the members of the College community.

For work in sugar mill practice (Sugar Mill Practice B), the seniors in the Sugar Technology Curriculum have been assigned to different sugar centrals, as follows: Manuel Hollero and Cornelio Lemoncito, Binalbagan Estate, Inc.; Florencio Ligon, Mount Arayat Sugar Central; Querino D. Rendon and Eleazar Sitchon, Pampanga Sugar Development Co.; and Fernando Fernandez, Central Azucarera de Tarlac.

Mr. Pedro David, instructor in agronomy at this College, who is now in the United States as a U. P. fellow, has recently been granted one year's extension in order to complete his requirements for a doctor's degree at Iowa State College.

Mr. Martin Caliñgasan, '27, is at present assistant manager of the hacienda of Mr. Vicente Madrigal in Muṇtinlupa, Rizal province.

The class in Agronomy 13 (Rice) made an extended trip through the rice-growing regions of Central Luzon. The party likewise visited the Central Luzon Agricultural School at Muñoz, Nueva Ecija.

An experimental baclad (fish corral), of the type commonly used in Laguna de Bay, was recently completed at the Los Baños Limnological Station in Mayondon. The catch is being used as material for study and for sale to the faculty and students of the College.

The class in Zoölogy lb (Vertebrate Zoölogy) made an educational trip to Manila, where they visited the different musea and fish markets, and collected specimens along the beach from Tondo to Malate. The party consisted of 112 members.

The Maquiling School for faculty children of the associated colleges at Los Baños presented a delightful Christmas program on the evening of December 19 at the College Auditorium. Songs, recitations, and a play entitled "The Christmas Star," in which the young pupils of the school participated, were the principal features.

A children's dress parade, under the auspices of the Maquiling Ladies' Club, was held at the College Campus on December 24. After the parade Santa Claus brought gifts to the little participants.

Christmas eve was fittingly celebrated by a party of students, headed by Miss Anne F. Cole, singing Christmas carols from house to house on the Campus and the Faculty Hill.

The annual military "hop" of the Department of Military Science and Tactics was held on the evening of December 7. Major Anastasio Q. Ver, 12th Cavalry (PS), was guest of honor. Young women from different dormitories of Manila attended. The occasion was a riot of colors and fun—and noise.

Of the five events scheduled for 1929-1930 by the U. P. Los Baños Intramural Athletic League, four have been completed. The freshmen captured the championships in basketball and in volleyball, while the sophomores copped the pennants for the track and field and relay carnival meets. The soccer football title will be decided in January among the three leading teams, namely, seniors, sophomores, and freshmen. C. Alkan, Inc., will award a banner to the winning team in each event and a silver cup to the general championship winner.

In extramural athletics, the U. P. Manila and U. P. Los Baños athletic teams were so well matched that it took three games each to decide the University championships in basketball, baseball, and volleyball, in which the city teams finally emerged triumphant, by very close margins. However, the Aggies came out victorious in two straight games in soccer football and with a monopoly of first places in the relay carnival. U. P. Unit IV (Los Baños colleges) was a close second in both the University Inter-Unit Boxing and Tennis Tournaments. In boxing, Los Baños was represented by Adolfo Castillo, Francisco Sevilleno, and Estanislao Yballo (Agriculture); Gil Pabillo and Vicente Hermoso (Veterinary); Magdaleno Caayupan (Forestry); and José C. Mendoza (Rural High). In tennis, José Utzurrum, José Austria, Pee Tek Hap, and Sawat Viradeja (Agriculture); Charas Suebsaeng (Veterinary) and Santiago Ledesma (Forestry) played for the Los Baños colleges.

The following Los Baños boys took part in the University teams at the annual U. P.-Silliman Dual Athletic Meet in Dumaguete, December 21 to 24: *Baseball*—Hermenegildo Farolan, Perfecto Ocampo, and Aniano Paner. *Relays*—Pascual Andres, Ceferino Magno, Amado Paggao, Theodore Schück, and Pedro Yatar. *Soccer football*—José Austria, Elias Grapa, Newton Jison, Thuan Komkris, Thonghaya Punyasingha, Charas Suebsaeng, and Tulaya Silpi.

The Governor General has recently appointed Dr. Manuel L. Roxas, '11, director of the newly created Bureau of Plant Industry, effective January 1, 1930. Doctor Roxas is emeritus professor of agricultural chemistry of the College of Agriculture, at which institution he was on the active faculty for seventeen years.

THE DIRECTOR OF THE NEW BUREAU OF PLANT INDUSTRY[1]

Announcement has just been received of the appointment of Dr. Manuel Luz Roxas, an outstanding alumnus of this College, as director of the newly created Bureau of Plant Industry. For the benefit of our foreign readers, it may be said in passing that the executive office known as the Bureau of Agriculture, which has been charged for the last three decades with the regulation and promotion of agricultural industries in the Philippines, has been split into two organizations to be known as the Bureau of Plant Industry and the Bureau of Animal Industry.

Doctor Roxas belongs to a small group of Filipinos who have enjoyed the benefits of both Latin and Anglo-Saxon education. In 1906 he was graduated from the Ateneo de Manila, then the most outstanding Spanish secondary school of the Philippines, as Bachiller en Artes. He subsequently entered the Philippine Normal School, at the time the highest school existing in the Islands under the American system of education, and was graduated in 1909 from its high school department. Upon the organization of the College of Agriculture he was one of its first students, and the most advanced. He was graduated in 1911 as Bachelor of Science in Agriculture, and two years later received his Master of Science degree.

As early as his student days young Roxas had already demonstrated unusual merit in scholarship and leadership. He was given charge of preparatory classes in mathematics and was generally recognized as the student leader of his time. He organized the student body into an association which looked after the varied aspects of student life. He was the first editor of *The Philippine Agriculturist*, which started publication at this time as a technical and scientific student journal. Shortly after his graduation in 1911 he was appointed assistant instructor in chemistry, at the same time he continued to teach classes in mathematics. In the words of Dean Copeland at this time, "For one of his years, Mr. Roxas is unusually mature in judgment." In 1914 he was appointed fellow of the University of the Philippines for foreign study and took residence for one year at the Massachusetts Institute of Technology with the object of improving his basic training in chemistry. In 1915 he removed to the University of Wisconsin where he received in 1917 the degree of Doctor of Philosophy, majoring in agricultural chemistry. Upon his return to the Islands he resumed service in the College of Agriculture as instructor, and subsequently became by promotion assistant professor, associate professor, professor, and finally head of the Department of Agricultural Chemistry. His services to the College have been exceptionally meritorious and the present organization of the Department of Chemistry is largely due to his efforts. Doctor Roxas had a very broad interest in, as well as understanding of, chemistry. His interest ran to biological, sugar, and fuel chemistry. He organized the Student Mess as a practical laboratory for the first, a small sugar central for the second, and wood-distillation furnace for the third. His inventive genius had full play in designing his first sugar plant out of tin cans and odds and ends of laboratory materials. This earned for him recognition and appropriations for more permanent equipment. He also interested himself in the construction of a copra drier, a coir machine, and a lime meter.

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[1] General contribution No. 227.

His interest in sugar put him in contact with sugar producers who immediately recognized his potential value to the industry. With the organization of the Philippine Sugar Association in 1924, he was employed part time as a cane technologist, returning to the College four months a year during the off-season. The demands on his time due to the extension of activities of the Sugar Association to include practically every central in the Islands finally induced him to sever his connection with the College of Agriculture.

He resigned in April, 1928, but the Board of Regents of the University of the Philippines, in recognition of his highly meritorious service, instead of accepting his resignation, allowed him to retire and elected him emeritus professor of agricultural chemistry.

In connection with his cane work Doctor Roxas made very valuable studies on cane cultivation, fertilization, variety tests, irrigation and drainage, as well as on cane breeding. It would be difficult to find another man as well versed in the different aspects of cane sugar production anywhere.

As a development of his interest in industrial chemistry he has studied the commercial possibilities of starch and alcohol manufacture from cassava, and sugar production from the nipa palm. His interest in animal nutrition led him to establish privately a commercial dairy in his home town, Lipa, Batangas.

A restless spirit, a confirmed optimist, resourceful, hard working, well trained, an inveterate scientist and investigator, always looking out for new things to do, or a way to do things better, Doctor Roxas needs just such an organization as the Bureau of Plant Industry to multiply his energies, and the Philippine Government is to be congratulated upon having acquired his services.

His Alma Mater, the College of Agriculture, feels proud of the accomplishments of Doctor Roxas, and in extending to him her congratulations for this signal recognition of his merits, wishes him Godspeed.

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STUDIES ON THE INHERITANCE OF COAT COLORS IN CROSSES INVOLVING PHILIPPINE NATIVE WITH HEREFORD AND NELLORE CATTLE—PRELIMINARY REPORT[1]

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A knowledge of the interaction of the factors that govern coat colors and color patterns among cattle would enable breeders to produce animals of uniform shades and in certain cases it could be used by cattle owners to identify their animals. Studies of the inheritance of coat colors in mice, originally started by Cuénot (1902–1907) some twenty years ago, confirmed by Little (1919) and others, have shown the existence of a definite association between homozygous yellow color and certain factors that may destroy (lethal) the life of the individual. The tortoise-shell pattern in male cats has been found by Doncaster (1905) and others to be quite generally correlated with sterility. The susceptibility of the white breeds of swine and the resistance of the black breeds to sunburn is well known to every animal husbandman. Scientists are now beginning to correlate the ability of the Nellore cattle to resist long periods of exposure to the intense heat of the tropical sun with the dark pigmentation of the skin and white hair coat of these animals. It is quite probable that associations exist between coat colors and color patterns and characters having great economic value, such as milk and beef production, resistance to disease or adverse condition, which if discovered will aid greatly in the difficult game of selecting desirable individuals. In all these lies the importance of the present studies.

Studies on the inheritance of coat color among cattle have not as yet been worked out satisfactorily owing to the fact that they have been based very largely upon records kept by breeders' associations of various kinds and such materials do not furnish the best possible information for genetic studies. For some ten years now cross-breeding experiments have been going on in the Department of Animal Husbandry, College of Agriculture, with an entirely different purpose—that of developing a type of cattle that will be suitable for draft and for beef, and which will be well adapted to Philippine range conditions. In the course of these experiments some data bearing on coat color have accumulated. While these data may be lacking in point of number, nevertheless they have a distinct advantage over the herd-book data in view of the fact that they have been secured from very carefully controlled matings of animals in the College herds comprising pure Hereford, pure Nellore, and Philippine Native cattle, all of which are fairly uniform in color.

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[1] Experiment Station contribution No. 596. Read before the Los Baños Biological Club January 30, 1930.

In this preliminary report we are presenting these data with the object of inviting criticism in regard to certain working hypotheses which have been used in our studies on the inheritance of coat colors and color pattern in cattle. Working hypotheses are provisional in nature and find justification only as guides for progressive experimental investigation.

HEREFORD × NELLORE CROSS

In our crossbreeding work three different crosses are being made, namely, (1) Hereford × Nellore, (2) Nellore × Native, and (3) Hereford × Native. On account of the period of isolation under which the Nellore and, to a less limited extent, the Native cattle have been placed and of the long years of consistent concentration of blood in the case of Herefords, one may expect the animals of these breeds to be fairly homozygous in their genetic makeup. But these crosses have produced a diversity of colors. Whether this is due to lack of purity or to the interaction of a number of different homozygous factors or to a combination of these conditions will be seen from the consideration of the results obtained so far. These results give some very interesting sidelights of the problem. In table 1 are presented the results of crossing Herefords with Nellores.

Herefords are phenotypically red and are probably so genetically. Nellores are phenotypically white, but indications are that they are really gray. White animals have unpigmented skins. The skins of Nellores are usually deeply pigmented, that is, almost black. For lack of a better term we will call the color of Nellores silver gray. As seen in the foregoing table, Hereford by Nellore matings brought three different types of color-patterns namely, (1) a pattern typified by November Fifth, Herd No. 84, November Eighth, Herd No. 85, and Romeo, Herd No. 101; (2) another type represented by Provincial Fair, Herd No. 93; and (3) a fawn type represented by Luz, Herd No. 130. Animals of the first type are brindled with black streaks on a yellow or orange background, the second is phenotypically black and the third is a dark fawn with dark extremities. Whether Luz and Provincial Fair are genotypically identical or not can not be ascertained. Castration has been observed to modify the expresion of colors and may throw some light on this point.

The only colors in cattle whose relationships have been definitely established are black and red. Present knowledge indicates that black and red are allelomorphs, black being dominant over red. These colors segregate in a clear ratio of 3 black to 1 red in F_2, showing the operation of a single pair of Mendelian factors. Wright's (1917) analysis of the coat colors of Highland cattle indicated that reds are constituted genotypically as *bbdd*, in which *b* stands for the gene that governs the production of red color and *d* is the gene or factor that does not dilute red, hence the color is intense red.

If the Highland and Hereford reds are conditioned by the same genetic factors, our results would indicate that the Nellore must carry the factor for black. Since black coat has appeared in the cross and the Herefords do not carry the gene for this color it could have come only through the Nellores. Similarly the factor *D* which dilutes black into dun or red into yellow or orange as typified by Luz and November Fifth, respectively, may have been carried by the Nellores. Further data, however, will be needed to substantiate these assumptions.

PHILIPPINE NATIVE × NELLORE

The matings between Native and Nellore have brought some very interesting results. Native cattle are phenotypically yellow or orange, but are probably not so genetically. As a result of extensive genetic studies of coat colors among cattle in England, Wilson (1909) has been able to classify the blacks, duns, yellows, and red colors. Wilson's yellows are typified by the Guernseys. These animals wear dilute red or yellow hair coat but their skins are yellow, while the skins of the Native cattle are very deeply pigmented. In other words they are similar to the Jerseys which are dun or fawn carrying the factor large *B* for black and the factor large *D* which dilutes black into dun and red into varying grades of yellow. Under such a classification the Native cattle must be dun or fawn and not yellow. Whether the colors which appear similar in the different breeds of cattle are really so genetically can only be determined by careful experiment.

At the outset one pertinent question might be raised. Since the Native and the Nellore cattle both carry the factor *B* for black, as well as the independent dominant dilution factor *D*, how are we to account for the dissimilarity in their appearance? To explain the difference in color between the animals in these two breeds we have assumed the presence of a factor for silver gray. This factor, which we will designate by *A*, is present in the Nellores and absent among the Natives. When present in homozygous condition it acts completely epistatic to *B* and *D* producing the complete expression of silver gray. In a heterozygous condition, however, it acts only incompletely epistatic to these factors allowing partial expression of the intergrades of black to dun and yellow to red. The latter relationship can be discerned by reference to table 2.

What led to the foregoing assumption is the result of mating Cleopatra, Herd No. 51, with Madras, Herd No. 21, a pure Nellore bull. Cleopatra is an old cow and has been in the College herd for over ten years. She was bought (1919) from Mr. Nicasio Villegas who gave the information that she was a daughter of Liberty, Herd No. 54 (see previous table 2.) Her sire was not known, but Mr. Villegas kept a pure Nellore bull in his herd. Cleopatra's color is light yellow not very different from that of the native, in fact she has been listed as such in our records. In our herd she produced four daughters which were sired by Nellore bulls. Two of these daughters, namely, Empress, Herd No. 59, and Dulcinea, Herd No. 105, are pale yellow gray of the type of Virginia, Herd No. 100, and Alice, Herd No. 104, while the other two, Prospect, Herd No. 61, and Irene, Herd No. 153, are silver grays just like pure Nellores. This fact led to the suspicion that Cleopatra might be a grade Nellore and not a pure Native. The proof that she carries Nellore blood is afforded by the matings between Cleopatra and a Hereford bull (Bonnie Lad 15). From these matings Almira, Herd No. 139 and Antonio, Herd No. 94, resulted. In point of conformation, anatomical features, and disposition these animals unmistakably show definite Nellore characteristics which they could not have gotten except through their dam.

The production of an equal number of silver gray and non-silver gray offspring by Cleopatra from a pure Nellore bull is a very strong indication of her being heterozygous for the silver gray factor. Now, if the hypothesis is correct, we may expect an even ratio of silver gray to non-silver gray colors by crossing all the heterozygous individuals back to the pure Nellore parents. This expectation is realized as seen in table 3. Of the thirteen offspring so produced six are silver gray and seven are not silver gray.

HEREFORD × NATIVE

The crosses involving Hereford and Native cattle lend further support to the assumption that the Native cattle carry the factor *B* for black as well as the factor *D* which dilutes black and red into various shades of duns and yellows as may be seen in table 4.

Summarizing the results presented in the foregoing table, we may say that crossing dun with red brought black, dun, brindle, yellow and red. This is not the first time that such results have been obtained. Wilson (1909) working on Highland cattle reported similar results, which he explained on the basis of triple allelomorphs. Wright (1917) has rearranged Wilson's data and appears to have explained the occurrence of such colors on the basis of two independent pairs of Mendelian factors; namely, a factor *B* for black with *b* for red as its allelomorph, and a factor *D* an independent dominant dilution factor with small *d* as allelomorph. The manner in which these two pairs of factors interact is shown in the following diagram.

Two-factor Hypothesis (After Wright) (1917)[a]

	DD	Dd	dd
BB	BBDD–cream dun	BBDd–dun	BBdd = black
Bb	BbDD–cream dun	BdDd–dun	Bbdd = black
bb	bbDD–cream or light dun	bbDd–yellow	bbdd = red

[a] Wright used *E* instead of *B*, and *e* instead of *b*, in his discussion. Symbol *B* for black has been used for the sake of clarity.

Our results can be explained on the basis of double allelomorphs provided it is assumed that some of the native cattle in our herd are heterozygous in one or both factors; thus: $BbDd \times bbdd = BbDd + Bbdd + bbDd + bbdd$ which are dun, black, yellow, and red, respectively. If such be the case Sampaga, Herd No. 90, is genetically constituted *BbDd* for she produced black and red, and Inasaran, Herd No. 89, and Estrella, Herd No. 75, are both *BbDD*. Certainly more data will be needed in order to determine whether this is the situation concerned in the present case. The above explanation does not account for the occurrence of brindle. It seems that this condition has to be explained in some other way.

INHERITANCE OF BRINDLES

To our mind the most striking color pattern that has come out in the foregoing crosses is the occurrence of brindles. Brindling is the appearance of irregular streaks or stripes of black on red, yellow, orange, or a dun background or any of the these colors on black. The word "tigre", tiger, has been given locally to this pattern. Brindling has been observed in different breeds of cattle, notably among Normandy and West Highland although its inheritance has not been definitely worked out as yet. But, so far as we have been able to aseertain, it is not a recognized color in Herefords and has not been observed in pure Nellores or Philippine native cattle. Furthermore actual breeding results in the College herd have shown that crosses between Nellores and natives do not throw any brindles. However, crossing Herefords by Nellores, Herefords by Natives, or Herefords by Nellore-Native F_1's, have produced brindled progeny. This can be readily discerned by reference to table 5.

It is seen from the foregoing table that the brindle and non-brindle classes occurred in the proportion of 17 to 20, respectively. That this proportion is a close fit to a one to one ratio is shown by the distribution of the sexes, namely, 20 males to 17 females, which happened to be exactly the reverse of the first ratio. The occurrence of such a ratio can be interpreted to mean that it was just as likely that the distribution of brindles to non-brindles might have fallen 17 to 20 as it was 20 to 17.

Claiming that in Highland cattle brindles were produced by mating dun or black brown with black, red, and light dun, Wilson (1909) concluded that brindling is a heterozygote of black and red or dun. On the other hand Wriedt (1919) contended that the condition is governed by an independent factor and not the heterozygote of black and red or dun inasmuch as his studies on the Telemark cattle in Norway showed that black is an extremely rare color among Telemarks while brindles are common. Furthermore he stated that mating brindle with brindle or brindle with red produced only brindle and red. Cole (1925) suggests the possibility that the operation of complementary genes coming from two parents might be concerned in the production of brindles. The fact that brindling comes out in a certain proportion of the second generation animals from Jersey-Angus cross, and in the first generation cross-breds from Red Danish with Jersey led to this conception. It is quite possible that characters which look alike may be inherited differently in different races of animals.

Are our results explainable on the basis of any of these three hypotheses or must we look for a different explanation? The points against heterozygosity as applied to our results are that both Nellore and Native cattle carry black and red and their various intergrades as affected by the dilution factor, yet brindles do not occur in these breeds. Furthermore, if it is the red coming from the Hereford that is necessary for the production of the pattern, we may expect a large proportion of brindles among the cross-breeds. Likewise, if due to complementary factors we would expect a larger percentage of brindles than fifty per cent unless it be assumed that exactly one half of the Native and Nellore cattle used do not carry the other complement. This is not likely the case.

If we must assume the operation of an independent Mendelian factor we should be forced to the conclusion that the Herefords must carry this factor, since our data show that brindling appears only in the cross-bred animals having Hereford blood, but this assumption is met with an apparently serious difficulty in view of the fact that brindle is not seen among pure Herefords. If this factor is borne by Herefords, how can it be explained that they do not show the characteristic at all? A proper understanding of the manner in which the factor for brindling operates removes this difficulty, however.

The factor for brindling may be viewed in the same light as the factor for spotting among rodents, the inheritance of which has been thoroughly worked out. It is now established that the gene for spotting does not become phenotypically visible unless the factor for color is concurrently present. Thus, animals carrying the spotting factor in a homozygous condition will be solid white and not spotted if they lack the color factor large *C*. In a similar manner brindling appears to require for its expression the presence of the factors for black and red or the intergrades of black and red as affected by the *D* factor. This condition is not met in Hereford since black is absent, consequently the genes for brindle may be present without making themselves apparent.

To explain our results a dominance of the factor for brindling over non-brindling must be assumed, for only on this basis can we account for the appearance of brindles in the first generation-cross. It must further be assumed that the two Hereford bulls used in the cross were both heterozygous for the character. The occurrence of an even ratio of brindles to non-brindles can best be explained on this basis. If these assumptions are correct, matings involving cross-bred non-brindled Herefords with pure Natives or Nellores should throw no brindles at all. This is realized as may be seen in table 6.

On the other hand, mating Elisa (shown in table 6) with Bonnie Lad 15th, produced three offspring, one of which, Norma, Herd No. 103, was brindled, the other two, Sara, Herd No. 128, and Asher, Herd No. 143, were not brindled, showing again that Bonnie Lad 15th must be heterozygous for brindling. A bit of critical evidence that lends further support to the assumption that brindling is governed by a single pair of dominant factors is given in table 7.

It is seen in table 7 that the matings involving brindled with non-brindled animals gave an even ratio of brindled and non-brindled offspring. This result may be expected if our hypothesis is correct. That Herefords in our stock probably do not all carry the determiner for brindling is indicated by the mating of the pure Hereford cows to non-brindled Hereford-Nellore F_1's. Provincial Fair, Herd No. 93, is one such animal. He was mated with Dolly, Herd No. 13, Margaret, Herd No. 14, and produced two offspring, Elsie, Herd No. 151, and Fidel, Herd No. 157, respectively, neither of which is brindled. Dolly, mated with Madras No. 21, a pure Nellore bull, produced non-brindled offspring. Two other Hereford cows, Miss Perfection, Herd No. 4, and Mary, Herd No. 17, mated with Madras, each produced one calf, neither of which is brindled.

That brindling is not a sex-linked characteristic is indicated by the almost even distribution of the sexes in the brindled and non-brindled groups seen in table 5. It is noted that of the seventeen brindled individuals, ten are males and seven are females, while a perfect equality of males and females (10 to 10) has resulted among the non-brindled group.

SUMMARY OF CONCLUSIONS

The following tentative conclusions can be drawn from the results presented in these studies:

1. Both Nellores and the Philippine Native cattle carry the determiners for black. An independent dominant factor for dilution which acts on black and red diluting these colors into various shades of dun and yellow, respectively, is also present in these breeds.
2. The difference between the Nellores and the Native cattle is due to a factor *A*, for silver gray, which factor is present in the Nellores and absent in the Natives. In homozygous condition this factor is completely epistatic to black and red as well as their intergrades showing the full expression of silver gray, the color of the pure Nellores. In heterozygous condition it acts only incompletely epistatic to the latter colors allowing partial expression of the hypostatic factors.
3. Brindling is due to an independent pair of Mendelian factors which is dominant over the non-brindled condition.
4. Herefords are reds and the animals we have worked with do not carry the genes for black. Consequently they may carry the factors for brindling without being apparent.
5. Although the evidences upon which these conclusions are based are fairly consistent in the sense that no deviations from expectations could

be detected, still on account of the limited data, these conclusions cannot be considered definitely established. The work must be continued until final conclusions can be drawn.

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TABLE 1

Results of crossing Indian Nellore cows with Hereford bulls

SIRE		DAM		OFFSPRING		
Name	Color	Name	Color	Name	Sex	Color
Dobbins......	Red	Catalina H. N. 11	Silver gray	November 5 H. N. 84	♂	Brindle, with streaks of black on an orange background.
Dobbins......	"	Petra H. N. 8	"	November 8 H. N. 85	♂	Brindle, with streaks of black on an orange background.
Dobbins......	"	Camia H. N. 29	"	Romeo H. N. 101	♂	Brindle, with streaks of black on a yellow background.
Dobbins......	"	Feliza H. N. 6	"	Provincial Fair H. N. 93	♂	Phenotypically black except for a narrow band of dun extending from the withers and on the back to the sacrum.
Bonnie Lad 15 H. N. 1	"	Feliza H. N. 6	"	Luz H. N. 130	♀	Dark fawn with black stocking.

TABLE 2

Results of mating Nellore × Philippine Native cattle

SIRE		DAM		OFFSPRING		
Name	Color	Name	Color	Name	Sex	Color
Nellore bull...	Silver gray	Liberty H. N. 54	Dun	Venus H. N. 57	♀	Dun, nearly like mother except that she has coarser hair and more white tipping.
Nellore bull...	"	Liberty H. N. 54	"	Active H. N. 65	♂	Dark gray turning cream gray after castration.
Marte H. N. 13.........	"	Liberty H. N. 54	"	Aladdin H. N. 97	♂	Dark gray turning cream gray after castration.
Madras H. N. 21.........	"	Sampaga H. N. 90	"	Virginia H. N. 100	♀	Pale yellowish or cream gray.
Madras H. N. 21.........	"	Inasaran H. N. 89	"	Alice H. N. 104	♂	Pale yellowish or cream gray.
Madras H. N. 21.........	" "	Estrella H. N. 75	"	Ali-Baba H. N. 106	♂	Pale yellowish gray with very small multiple dark spots.
Madras H. N. 21.........	"	Matea H. N. 174	"	Paz H. N. 175	♀	Yellowish gray with white spotting.
Madras H. N. 21.........	"	Batangas H. N. 76	"	Rowena H. N. 112	♀	Dark gray with white spotting.

TABLE 3

Results of backcrosses involving Nellore-Native F_1's to a pure Nellore

SIRE	DAM	OFFSPRING		
Pure Nellore	Nellore-Native F_1	Silver gray	Sex	Non-Silver gray
Madras H. N. 21.	Venus H. N. 57		♂	Victor H. N. 66
Madras H. N. 21.	Venus H. N. 57	Juliet H. N. 99	♀	Eugenio H. N. 166
Madras H. N. 21.	Venus H. N. 57		♂	
Madras H. N. 21.	Alice H. N. 104		♀	Belinda H. N. 141
Madras H. N. 21.	Alice H. N. 104		♀	Basilisa H. N. 159
Madras H. N. 21.	Virginia H. N. 100	Dorinda H. N. 145	♀	
Madras H. N. 21.	Virginia H. N. 100	Rustum H. N. 164	♂	
Madras H. N. 21.	Dulcinea H. N. 105	Zamboanga H. N. 146	♀	
Madras H. N. 21.	Rowena H. N. 112		♀	Rita H. N. 162
Madras H. N. 21.	Cleopatra H. N. 51		♀	Empress H. N. 59
Madras H. N. 21.	Cleopatra H. N. 51		♀	Dulcinea H. N. 105
Madras H. N. 21.	Cleopatra H. N. 51	Prospect H. N. 61	♀	
Madras H. N. 21.	Cleopatra H. N. 51	Irene H. N. 153	♀	
Total.		6	13	7

TABLE 4

Results of crossing Hereford with Native cattle

SIRE		DAM		OFFSPRING		
Name	Color	Name	Color	Name	Sex	Color
1. Dobbins.	Red	Liberty H. N. 54	Dun	New Year H. N. 87	♂	Brindle, with black streaks on a light dun background.
2. Bonnie Lad 15. . .	"	Liberty H. N. 54	"	Joan of Arc H. N. 108	♀	Fawn, or dun with dark extremities.
3. Bonnie Lad 15. . .	"	Liberty H. N. 54	"	Arthur H. N. 132	♂	Brindle, with black streaks on a yellow background.
4. Bonnie Lad 15. . .	"	Sampaga H. N. 90	"	Shylock H. N. 111	♂	Red, red hair and unpigmented skin just like the Hereford.
5. Bonnie Lad 15. . .	"	Sampaga H. N. 90	"	Banquo H. N. 136	♂	Phenotypically black. A small patch which is dun in color is found behind the withers.
6. Bonnie Lad 15. . .	"	Batangas H. N. 76	"	Amelia H. N. 135	♀	Brindle, with black streaks on a dun background.
7. Bonnie Lad 15. . .	"	Batangas H. N. 76	"	Vera H. N. 149	♀	Fawn or dark dun, with dark extremities and long hair.
8. Bonnie Lad 15. . .	"	Inasaran H. N. 89	"	Athos H. N. 114	♂	Deep red or Brazil red.
9. Bonnie Lad 15. . .	"	Estrella H. N. 75	"	Dorcas H. N. 144	♀	Dark red with white stocking.
10. Bonnie Lad 15. . .	"	Matea H. N. 174	"	Barrio	♂	Fawn or dark dun, with dark extremities.

TABLE 5

Proportion of brindle to non-brindled progeny in crosses involving (a) Hereford × Philippine Native (b) Hereford × Nellore, and (c) Hereford × Nellore-Native F_1's.

		SIRE		DAM		OFFSPRING			
		Name	Color	Name	Color	Brindle	Sex		Not brindle
							♂	♀	
(a)	1.	Bonnie Lad 15....	Red	Liberty H. N. 54	Dun	New Year H. N. 87	1		
	2.	Bonnie Lad 15....	"	Liberty H. N. 54	"			1	Joan of Arc H. N. 108
	3.	Bonnie Lad 15....	"	Liberty H. N. 54	"	Arthur H. N. 132	1		
	4.	Bonnie Lad 15....	"	Sampaga H. N. 90	"		1		Shylock H. N. 111
	5.	Bonnie Lad 15....	"	Sampaga H. N. 90	"		1		Banquo H. N. 136
	6.	Bonnie Lad 15....	"	Batangas H. N. 76	"	Amelia H. N. 135		1	
	7.	Bonnie Lad 15....	"	Batangas H. N. 76	"			1	Vera H. N. 149
	8.	Bonnie Lad 15....	"	Inasaran H. N. 89	"		1		Athos H. N. 114
	9.	Bonnie Lad 15....	"	Estrella H. N. 75	"			1	Dorcas H. N. 144
	10.	Bonnie Lad 15....	"	Matea H. N. 174	"		1		Barrio
(b)	1.	Dobbins..........	Red	Catalina H. N. 11	Silver gray	November 5th H. N. 84	1		
	2.	Dobbins..........	"	Petra H. N. 8	"	November 8th H. N. 85	1		
	3.	Dobbins..........	"	Camia H. N. 29	"	Romeo H. N. 101	1		
	4.	Dobbins..........	"	Feliza H. N. 6	"		1		Provincial Fair H. N. 93
	5.	Dobbins..........	"	Feliza H. N. 6	"			1	Luz H. N. 130
(c)	1.	Bonnie Lad 15....	Red	Cleopatra H. N. 51	Dun		1		Aramis H. N. 115
	2.	Bonnie Lad 15....	"	Cleopatra H. N. 51	"		1		Model H. N. 63
	3.	Bonnie Lad 15....	"	Cleopatra H. N. 51	"	Los Baños H. N. 77	1		
	4.	Bonnie Lad 15....	"	Cleopatra H. N. 51	"		1		Antonio H. N. 94
	5.	Bonnie Lad 15....	"	Cleopatra H. N. 51	"			1	Almira H. N. 139
	6.	Bonnie Lad 15....	"	Independence H. N. 58	Pale yellowish gray	Loyalty H. N. 79	1		
	7.	Bonnie Lad 15....	"	Independence H. N. 58	"	Iago H. N. 107	1		
	8.	Bonnie Lad 15....	"	Independence H. N. 58	"		1		Adams H. N. 118
	9.	Bonnie Lad 15....	"	Independence H. N. 58	"	Priscilla H. N. 96		1	
	10.	Bonnie Lad 15....	"	Independence H. N. 58	"	Hope H. N. 131		1	
	11.	Bonnie Lad 15....	"	Independence H. N. 58	"	Julia H. N. 147		1	
	12.	Bonnie Lad 15....	"	Venus H. N. 57	"	Shine H. N. 88		1	
	13.	Bonnie Lad 15....	"	Venus H. N. 57	"	Rebecca H. N. 110		1	
	14.	Bonnie Lad 15....	"	Venus H. N. 57	"	Cenci H. N. 134		1	
	15.	Bonnie Lad 15....	"	Venus H. N. 57	"			1	Carolina H. N. 121
	16.	Bonnie Lad 15....	"	Venus H. N. 57	"		1		Don Mariano H. N. 150
	17.	Bonnie Lad 15....	"	Empress H. N. 59	"			1	Elisa H. N. 78
	18.	Bonnie Lad 15....	"	Empress H. N. 59	"			1	Lady Clair H. N. 113
	19.	Bonnie Lad 15....	"	Empress H. N. 59	"			1	Babbie H. N. 138
	20.	Bonnie Lad 15....	"	Empress H. N. 59	"	Ben H. N. 125	1		
	21.	Dobbins..........	"	Empress H. N. 59	"			1	Evangeline H. N. 102
	22.	Dobbins..........	"	Prospect H. N. 61	Silver gray	Prospect Last H. N. 98	1		
		Total..............	....	....	....	17	20	17	20

TABLE 6

Results of mating between pure Native, N-n F₁'s, or N-n×Hereford cross with pure Nellores, or N-n×Herefords cross[a, b]

SIRE		DAM		OFFSPRING			
Name	Blood Composition	Name	Blood Composition	Name	Sex	Brindle	Not Brindle
Model H. N. 63	N-n×Hereford cross	Batangas H. N. 76	Native	Clara H. N. 123	♀		1
Model H. N. 63	“ “	Liberty H. N. 54	“	Alfred H. N. 119	♂		1
Model H. N. 63	“ “	Sampaga H. N. 90	“	Celestine H. N. 122	♀		1
Model H. N. 63	“ “	Inasaran H. N. 89	“	Luisa H. N. 124	♀		1
Model H. N. 63	“ “	Cleopatra H. N. 51	N-n F_1	Armstrong H. N. 12	♂		1
Madras H. N. 21	Nellore	Joan of Arc H. N. 108	“	Cora H. N. 142	♀		1
Madras H. N. 21	“	Joan of Arc H. N. 108	“	Vicente H. N. 161	♂		1
Madras H. N. 21	“	Evangeline H. N. 102	N-n×Hereford cross	Barbara H. N. 140	♀		1
Madras H. N. 21	“	Elisa H. N. 78	“ “	Paula H. N. 160	♀		1
Provincial Fair H. N. 93	H-N F_1	Matea H. N. 174	Native	Matea 3rd	♀		1
Provincial Fair H. N. 93	“	Gumamela H. N. 62	H-n×Hereford	Helen	♀		1
				Total		0	11

[a] N-n = F_1 cross from Nellore by Native.
H-n = an F_1 cross from Hereford by Native.
H-N = an F_1 cross from Hereford by Nellore.

[b] Not a single animal noted in the table is brindled.

TABLE 7

Results of mating involving the brindled offspring of Bonnie Lad 15th and Dobbins with pure Nellore

SIRE		DAM		OFFSPRING			
Name	Pattern	Name	Pattern	Name	Sex	Brindle	Non-brindle
1. Madras H. N. 21	Non-brindle	Shine H. N. 88	Brindle	Ciriaco H. N. 155	♂	1	
2. Madras H. N. 21	“	Shine H. N. 88	“	Ada H. N. 117	♀		1
3. Madras H. N. 21	“	Priscilla H. N. 96	“	Diva H. N. 127	♀	1	
4. Madras H. N. 21	“	Priscilla H. N. 96	“	Paris H. N. 152	♂		1
5. Madras H. N. 21	“	Rebecca H. N. 110	“	Benito H. N. 154	♂		1
Total						2	3

RAMAI RICE AND ITS INTRODUCTION AND CULTURE IN THE CENTRAL LUZON AGRICULTURAL SCHOOL[1]

VICENTE B. ARAGON

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Formerly Farm Manager
Central Luzon Agricultural School

WITH TWO TEXT FIGURES

Because of the growing interest of rice growers in the culture of the Ramai variety of rice and at the request of some College of Agriculture authorities the writer has prepared this paper which embodies his five years experience with this variety.

The Ramai variety of rice was not known at the Central Luzon Agricultural School at Muñoz until about June, 1924, when one-half kilogram of seed was obtained by the writer from the local Bureau of Agriculture. The seed was planted in the seed bed and when the seedlings were about forty days old, were pulled up, sorted and transplanted in the trial plot—one plant to each hill. At the 1924-1925 rice harvest six cavans and twelve kilograms of Ramai seed were produced from the original one-half kilogram of seed obtained from the Bureau of Agriculture.

In the year 1925-26, four cavans of this Ramai seed were planted and the Ramai production in February, 1926, amounted to 425 cavans. 205 cavans of Ramai seed were planted in the year 1926-27 and more than 20,000 cavans of Ramai were produced in February, 1927.

Some of the Ramai seed produced by the Central Luzon Agricultural School in February, 1926, was sold to the Bureau of Agriculture and some to farmers in Pangasinan, Bulacan, Tarlac, Pampanga, and Nueva Ecija at ₱5.00 a cavan, and it is reported that this variety of rice is doing well in those places. Many farmers in Muñoz and in adjacent municipalities who tried the Ramai variety reported that it was the most productive variety of rice they had ever grown.

CULTURAL METHODS IN C. L. A. S.

Ramai is a lowland variety of rice which requires plenty of water during its long growing season. It has to be transplanted in order to secure the maximum yield. Transplanting Ramai seedlings from June 20th to about the end of July has been proved to have a direct effect upon the yield. Either late planting or a typhoon during the heading season is likely to do serious damage to the crop.

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[1] General contribution No. 226. Published with permission of the Director of Education. Received for publication November 23, 1929.

At the Central Luzon Agricultural School during the period twenty to forty days after transplanting, the Ramai plants grow from twenty to seventy millimeters a day. During September the growth of the plants is quite slow as it is at this time that the stools develop. After the plants have passed the stooling period the growth is again rapid until the plants begin to form heads. When rank growth occurs the usual practice is to top the plants. Topping may be done three or four times, but it should be so that the last pruning is at least fifteen days before the heads come out.

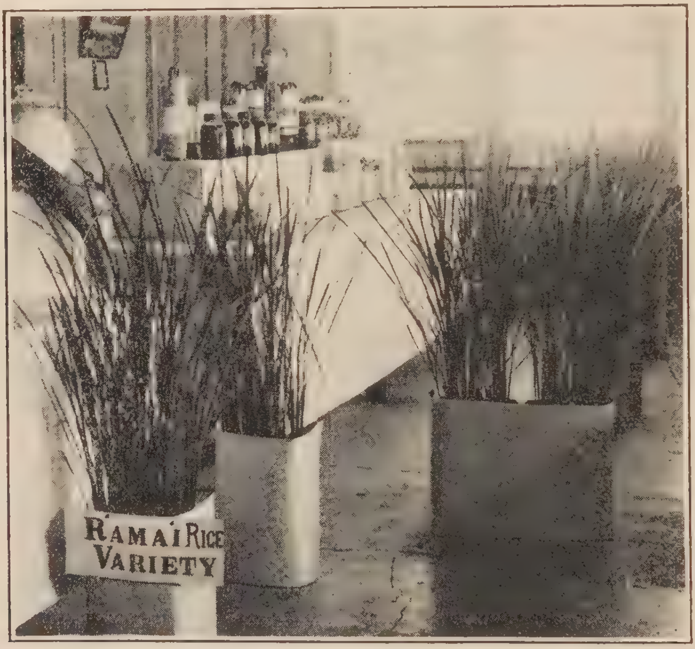

Fig. 1.—Ramai Rice in Pots for Exhibition.

On ordinary irrigated rice land at the School Ramai gave an average yield of 100 cavans each hectare. Lucio V. Lopez, formerly municipal president of Muñoz, Nueva Ecija, commenting on the Ramai variety of rice, said, "I have obtained remarkable results with the seed Ramai I secured from the School. From the five cavans of Ramai seed planted, I harvested a little over 700 cavans." Other farmers who bought seed from the School report that they also have produced at least 100 cavans each hectare.

SEEDS AND SEED SELECTION

The Ramai that the School is planting and selling every year is selected seed. Sixteen plots of about 15×20 meters each are planted every year with sixteen of the best producing varieties of rice found in Central Luzon, each variety occupying one plot. One of these sixteen plots is planted to selected Ramai seed every year. The seedlings are transplanted to the seed plot—one plant to each hill and the hills are spaced twenty centimeters apart. A week or two after the seed plot is planted a student is assigned to go over the seed plot to replant the vacant spaces where the plants failed to grow.

Shortly after the plants in the seed bed have passed the milk stage and while they are still standing, seed for planting in the following year is selected by the following method. The hills that have an average number of stalks or even more, and which bear heads of uniform length are selected. The panicles of the plants selected are of almost the same size and well developed. Those which have many undeveloped grains are not chosen. Care is taken to avoid hills near the dikes which for this reason produce vigorous stalks. Also those near vacant spaces where the transplanted seedlings failed to grow are not selected as they probably have more vigorous stalks than those in the middle of the plot because of the abundance of plant food elements in those places.

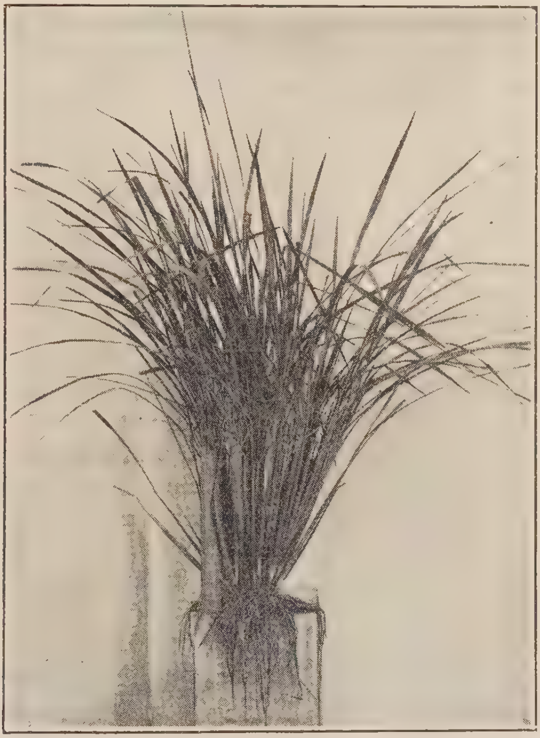

Fig. 2.—Ramai Rice with Root System Exposed.

The selected plants are then marked by driving stakes near the base of the selected hills. Talahib stalks may be used for this purpose. A few days before the plants in the seed plot are cut the selected ones are harvested, dried thoroughly, threshed and cleaned and before the seed is properly stored. Tthe grains that are dark and show signs of rice smut are separated from the good ones and fed to chickens or thrown away. The rest of the harvest from the seed plot is used as seed rice for the main field for the following year and the selected seed is planted the following year in the seed field. This method of selection is continued annually for four years, after which all of the last harvest from the seed field is planted in a seed bed, all transplanted in the main field and the produce saved as seed rice. This process of selecting Ramai seeds is practiced in the Central Luzon Agricultural School every year, and only well selected, improved seed is planted and sold.

SEED BED

The seed bed may be of any kind of soil, but fairly rich, light soil which can be watered and easily drained is preferred. The preparation of the seed-bed is most thorough. The ground is plowed once, then, two or three days later, it is plowed crosswise. Water is turned into the seed bed immediately after it is crossplowed and is allowed to stand at least five days, after which it is drained off, the bed is harrowed three or four times, puddled very well and leveled. Two days before the final puddling and leveling of the seed bed, the seed rice in the sacks is soaked in water for at least twelve hours. The sacks of rice seed are then removed from the water and placed in a shady place for at least twenty-four hours to allow the seeds to germinate. The germinated seeds are then sown broadcast as uniformly as possible in the already prepared seed bed at the rate of one cavan of seed to every 400 to 500 square meters of ground. During the first week after broadcasting the seeds, just enough water to keep the seed bed uniformly moist is turned in, and thereafter the ground is saturated with water at least once a week if it is not raining. Unless the seedlings are badly attacked by worms the seed bed is never flooded as too much water makes the seedlings too soft and a considerable number would be destroyed when they are pulled up for transplanting.

SOIL AND PREPARATION OF THE FIELD

On light soil Ramai can be grown successfully if there is sufficient humus and if the supply of irrigation water or rain is constant. Relatively rich clay or clay loam soil is ideal for this variety. On acidic clay soil fertilized with air-slaked lime at the rate of 400 kilograms each hectare it has been grown successfully.

Thorough preparation of the field cannot be overemphasized. The field is plowed about six inches deep when most of the seeds of weeds and grass have already germinated. This is usually done in Muñoz during the latter part of June. Plowing is done in such a way that all grass and straw are turned under. It is always best to plow the field early in June, let it stand for about two weeks to allow all weed and grass seeds to germinate and then to plow it for the second time, if there are plenty of draft animals that can be used. After plowing, enough water is turned into the field to cover the clods and a day or two later the field is harrowed lengthwise to break down the clods. Immediately after the first harrowing all holes in the dikes are closed and as much water as the dikes can hold is turned into the field and allowed to stand for at least a week. This will be sufficient time to kill all grass and noxious weeds that were turned under water. The water is drained off after a week and a crosswise second harrowing follows. Afterward the field is again thoroughly watered and allowed to stand for three or four days to let the weeds and grass decay further. The third harrowing, puddling and leveling of the field follow three or four days after the second harrowing. Only very little water is allowed to remain in the field while it is being puddled and leveled so that transplanting is accomplished more quickly and the seedlings inserted deeper into the mud. The field prepared in this way is ready for transplanting.

TRANSPLANTING

When the seedlings are from 35 to 50 days old the ground of the seedbed is completely saturated with water and the seedlings are pulled up, tied in bundles of about seven to ten centimeters in diameter and the tops cut off. Topping prevents too much evaporation from the leaves and also prevents the newly transplanted seedlings from being blown down by wind before the roots are well established in the soil. The bundled seedlings are then scattered all over the field immediately after it is prepared and then transplanted with from two to four seedlings in every hill. The hills are spaced about twenty centimeters apart. As the Ramai variety stools unusually well, thicker and closer planting than is recommended above would eventually decrease the yield and at the same time increase the number of seedlings needed to plant a hectare of ground. From seven to nine planters are needed to plant a hectare a day, each working eight hours. Taking ten centavos an hour as the wage of each student transplanting rice at the School the total cost of transplanting one hectare of Ramai would be about six pesos and forty centavos, which is very much less than a farmer usually spends in transplanting a hectare of rice in any other place inNueva Ecija. Some of the probable reasons for the lower cost of transplanting a hectare of Ramai rice in Muñoz are: the seedlings raised are very vigorous, the seed-bed for a cavan has an area of from 400 to 500 square meters; the planters at the School are all male students who naturally move and plant faster than women and children planters hired by common farmers; and last but not least is the close supervision given the student rice planters. During the rice planting in Muñoz all academic classes are closed and all students help to plant rice. All classroom teachers too go out to the rice field and each of them supervises from ten to twenty students who are assigned to plant.

A week after transplanting four or five centimeters of water is turned into the field to check the growing of noxious weeds and grass.

IRRIGATION

The usual practice of irrigating the rice field in Muñoz is to maintain the depth of water from eight to fifteen centimeters while the rice plants are from one to two months old and to gradually deepen the water thereafter reaching the maximum depth of twenty-five centimeters during September and October. It has been proven at the School that Ramai, unlike other varieties of lowland rice, can stand flooding for as long as eight days and will yield well so long as the current is not strong. Experience with this variety of rice shows that it grows most luxuriantly and produces the best crop in a field which has plenty of flowing water, the depth of which never becomes shallower than a foot from the time the plants are two months old to about the end of October, twenty-five or thirty days before the heads come out. In all cases the Ramai production is heavier where the water is deeper than where the water is shallow.

The practice of some of the farmers in the irrigated regions of Nueva Ecija of letting the rice field dry up for a week or two to encourage the development of stools was tried in some plots at Muñoz for several years. The result was that weeds of all kinds grew in almost all parts of the fields and a group of students had to be assigned to do the weeding of those particular plots.

As to when irrigation should cease is the problem of each student farmer. It depends largely upon the weather condition, drainage facilities and character of the soil. When a field is uniformly moist and no more rain is expected it is always best to give the field the last irrigation immediately after the rice plants have passed the milk stage. The last irrigation should be thorough and should not be deeper than eight centimeters in case of light soils and five centimeters in case of clay soils.

WEEDING

There are five most common weeds found bothering all the lowland rice in Muñoz including Ramai. These are the *Monochoria hastata* Linn., *Pistia stratiotes* Linn., *Eichornia crassipes* Mart., *Cyperus iria* Linn., and *Cyperus haspan* Linn. The first three are very often found crowding and choking the rice plants, and if they are not picked out by hand the yield is not as heavy as expected. These weeds are sometimes gathered by the students and fed green to their pigs. *Cyperus iria* and *Cyperus haspan* are found in the fields which are not constantly supplied with water. These weeds are hard to eradicate once they have started to grow. They have to be pulled up by hand in order to secure a heavy crop. Turning into the field as much water as the dikes can hold immediately after weeding helps check the growth of other noxious weeds.

PESTS

The rice leaf roller, *Cnaphalocrosis medinalis* Guen., was found attacking most varieties of lowland rice at the School, especially when planted late in July and August. In the case of Ramai variety the writer remembers only one case when this pest did serious damage to the rice plants in a small plot and that was late in August, 1928, when a group of four student farmers who had extra Ramai seedlings were assigned to plow and plant a piece of very low land along the provincial road. About two weeks after planting, that is, before the plants were able to take root, an outside neighbor's field where the plants were badly infested by leaf roller was flooded and most of the worms were carried into the students' newly planted field. Because the water was very deep and the plot was hardly 4×10 meters in size the students left the rice plants at the mercy of the worms and the flood. Two weeks later the water subsided but the Ramai plants were already too weak to recover. The Ramai rice plants are also found less susceptible to the attack of the rice bug, *Leptocorisa acuta* Thunb., and to the stalk borer, *Schoenobius incertellus* Wlk., than the other varieties of lowland rice grown in the same School.

HEADING AND HARVESTING

Ramai is supposed to be a 202 day variety, but after acclimatizing it in the Central Luzon Agricultural School it was found to mature in 195 days at that place. It forms heads in from 162 to 165 days after the seeds are sown in the seed-bed. It is possible that by annually selecting for planting purposes all the prolific plants that are found maturing four or five days ahead of the rest in the field, the maturity period might be cut down to about 185 days.

The plants are ready for harvesting when the lowest grains in the head are yellow. Harvesting usually begins in Muñoz about December 24th and lasts until January 15th. It is always done by students who use an implement called *pangapas*. The rice plants are cut half way between the tip of the head and the base of the plant and are left in thin piles to allow the rice to dry. The piles of cut rice are put on top of the straw left uncut and are so made that when put together two piles would make a bundle about 30 centimeters in diameter. With the ordinary lowland variety of rice ten or twelve students expert in harvesting can reap a hectare in 8 hours, but in the case of Ramai variety fifteen students would have a hard time to reap a hectare in 8 hours. This is due to the fact that Ramai stools unusually well.

Bundling follows three or four days after harvesting. *Buri* leaves are used for tying. The bundles are stacked temporarily in the field, each stack containing 41 bundles. Temporary stacking is important because it prevents the grain from getting wet when it rains. Later the bundles are hauled to the threshing bed and stacked once more, each stack when threshed may contain from 50 to 250 cavans. All stacks are built so that they are in a straight line and very near each other so that the thresher does not have to be moved far.

THRESHING

A space of about 15×15 meters is cleaned around each stack in the threshing floor. The cracks in the ground are covered with earth and the cleaned area is plastered with a thin layer either of clay or fresh carabao manure. This minimizes the loss of grain which would otherwise fall into the cracks and be wasted. When the machine and the floor are ready, threshing of the rice is begun. Eight to ten students are employed to work in the threshing machine. The machine threshes from 500 to 600 cavans a day of eight hours work. Because of the extraordinarily large size of the grains of Ramai from 3 to 5 per cent of the threshed grain is hulled. This undoubtedly makes it difficult to store Ramai palay longer than five months in the granary because the grain will be attacked by weevils. Ramai rice for seed is always threshed by the more primitive method which is treading out by carabaos. Although this is a slow process, it is the best way of threshing seed rice as the seed so threshed gives as high as from 96 to 100 per cent germination when properly cleaned.

HAULING THE THRESHED RICE

The rice in the sacks is hauled, weighed and poured in the School granary immediately after threshing. To do away with the heavy work of carrying the sacked rice on the shoulders and pouring it in a huge pile in the granary, the School has installed an elevator which carries up the grain from a big box. This elevator when working in good order pours from 1,200 to 1,600 cavans a day working ten hours a day. The rice is stored in the granary until about April when milling of the grain begins.

A COMPARATIVE STUDY OF THE DIFFERENT METHODS OF PREPARING COPRA[1]

ELIGIO C. CRUZ

WITH ONE PLATE AND ONE TEXT FIGURE

Philippine copra is facing serious competition in foreign markets, which, indications tend to show, will become more serious in the future. In order to meet this competition it will be necessary to exercise the utmost care in preparing Philippine copra for export.

Review of literature

Brill, Parker, and Yates (1917) reported that the annual exports of copra from the Philippines represented approximately one-third of the world's output. This was the situation up to 1926, as shown by statistical bulletins of the Philippine Islands issued between 1917 and 1926. These bulletins report that in 1927 the total value of Philippine copra and coconut oil exported to other countries was ₱87,992,847. The greater portion of these products comes from southern Luzon and the rest from the districts around Cebu, Negros, and Panay, and from some of the coconut regions of Mindanao. Most of this copra is dried by the ordinary *tapahan* method. Roxas (1926) in his study of comparison between the *tapahan*[2] copra and that mechanically dried states that the product from the *tapahan* method is placed among the poorest grades in the world's market. There have been many attempts to introduce improved methods of making copra in the Philippines. Cox (1917) attempted to eliminate much of the smoke in the *tapahan* method, but the copra was found to be unevenly dried. By using sun-drying in conjunction with *tapahan*, a more evenly dried product could be obtained. Those who have studied the question claim that driers which would eliminate the smoke and could be readily operated in uncertain weather are the only possible means by which the quality of the Philippine copra can be improved. But the initial and operating expenses of such driers seem to be too great to warrant their general adoption. According to Cox (1917) the mechanical drying machines have been discredited by the public through the belief that when the coconut meat was dried in a current of hot air a part of the oil is carried away from the copra. Walker (1906) pointed out that mold affects seriously the quality and quantity of improperly dried copra. Hines (1914) states that numerous experiments have proved that under ordinary conditions, copra containing five per cent or less of water would remain unaffected in quality even during the wet season, and the little water which it may absorb does no harm to the oil. Lava (1928) found that under an external relative humidity of 81 per cent, copra may be kept for at least a month with a water content of 8 per cent (dry basis) without molding or acquiring a rancid odor. He states also that in the *tapahan* method the creosote by-product of the burning of the shells and husks help in preserving the native copra.

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[1] Thesis presented for graduation, 1929, with the degree of Bachelor of Science in Agriculture from the College of Agriculture No. 294; Experiment Station contribution No. 620. Prepared in the Department of Agronomy under the direction of Dr. Vicente C. Aldaba.

[2] *Tapahan* (Tagalog) is a grill for drying coconut meat.

Object of the present work

It was the object of this investigation to determine the relative merits of each method by studying the expense involved, the quality of the products, and the profit made after selling the copra in the open market.

Time and place

Investigations were carried out in the provinces of Tayabas and Laguna and in the city of Manila, and experiments were conducted in the College of Agriculture and nearby places.

The study was begun April 6, 1927, and closed December 31, 1928.

MATERIALS AND METHODS

Copra making

Sun-drying method. Sun-drying is the simplest and probably the oldest method of drying copra. Very good copra may be produced by this method if the drying is properly performed.

The writer studied the sun-drying method in the College of Agriculture in April, 1927. One hundred mature nuts from the barrio of San Antonio, Los Baños, were used. The nuts were husked, cut into halves, spread out on a cement floor, and for five days, from seven o'clock in the morning to five o'clock in the afternoon, were exposed to the sun. After the first day of drying, the meat was separated from the shell by means of a *lucaran*[3]. At the end of each day samples were taken and the moisture content determined in the Chemistry Department of the College of Agriculture.

The copra was placed in sacks and kept in the laboratory. The changes taking place in the samples while in storage were observed. The grades of copra were determined according to the standards followed in the Bureau of Commerce and Industry.

Tapahan methods. A much quicker way of drying copra than by sun is by the *tapahan* method. But this method has been condemned as unscientific and brings discredit on the copra industry because of the poor copra produced.

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[3] *Lucaran* (Tagalog) is a native tool which resembles a coconut meat grater without teeth.

There are two types of the *tapahan.*

Laguna type. In Laguna Province the *tapahan* most commonly used is constructed by digging a square or rectangular hole in the ground. Bamboo or iron slats or split coconut trunks are placed over the hole at the same level as the ground, thus serving as a sort of grill on which the coconut meat is placed. The furnace is an open rectangular hole connected by means of a short tunnel with the hole beneath the grill.

The Los Baños *tapahan* differs from the Santa Cruz in the furnace. The mouth of furnace of Los Baños *tapahan* is square, while in Santa Cruz it is rectangular. (See Plate 1, fig. 1, 2, 3 and 4). Both furnaces are dug in the ground just a few centimeters away from the hole under the grill. In the construction of the furnace the Pagsanjan *tapanhan* is quite different from either the Santa Cruz or the Los Baños. As the *tapahans* in Pagsanjan are commonly built near the bank of the river there is no need of digging special hole for the furnace. The furnace is made by building several adobe steps, leaving a gap of about 30 centimeters for the fire. (See Plate 1, fig. 5 and 6.)

Tayabas type. In Tayabas the *tapahan* commonly found differs from the Laguna type in construction. No hole is dug; the grill is either square or rectangular and is about a meter above the ground. To keep the heat under the grill, the space under it is enclosed with halved bamboo stems, put close together.

One of the best kinds of *tapahan* is found in Sariaya, Tayabas. It differs from the Tayabas type. Plate 1, fig. 7 and 8 show this difference. The heating chamber is at some distance from the drying chamber. Specifications and dimensions for this *tapahan* are shown in tables 1 and 2. There is a narrow underground tunnel 70×66 cm. and about four meters long, which slopes toward the drying chamber. The grill is made of one-eighth inch steel rods placed about two centimeters apart. As may be seen in Plate 1, fig. 7 and 8, the grill is provided with iron wheels so as to facilitate arranging and drying of nuts. In some of the driers, there are two grills so that while one is over the drying chamber, the workers may put on or take off nuts from the other.

Hot-air methods

New College copra drier. This drier is claimed to be an improved method because it utilizes the heat from burning husks and shells without allowing the smoke to come in contact with the meat, as in the ordinary *tapahan.* Table 1 gives full data on the size of the furnace and chambers. The drier consists of a Dutch oven and combustion chamber, the temperature control device, the drying chamber, the preheater where the half-nuts are heated before the meat is removed, the smoke stack, the cooling platform and the bagging device. These parts are shown in Plate 1, fig. 9 and 10. The drying chamber is provided with an endless conveyor on which the coconut is laid.

Dessicated coconut factory method. The method employed in the Franklin Baker Company factory in San Pablo, Laguna, utilizes steam from a boiler. There is an enclosed chamber provided with tubes of various sizes which are connected to a large exhaust steam pipe. To maintain uniform heat throughout the chamber and to increase the speed of water evaporation, there are several fans inside the drying chamber. Like the new College copra drier, it has an endless apron on which the parings[4] are dried and at the same time conveyed to the sacks. This apron is run by a pulley connected with a shaft. The parings are dried into copra in 45 minutes. The temperature is kept constant at 80°C. From nuts which are not suitable for making dessicated shredded coconut, copra is made. It takes 22 hours to dry this meat into copra.

Storage

Samples were put in small gunny sacks and placed in a room with a cement floor and with ventilation by windows and a door. Daily observations of the change of the copra in storage were made. The length of time before mold appeared on copra containing different amounts of moisture was observed.

Grades of copra

The Bureau of Commerce and Industry furnished the writer with information regarding standard grades of Philippine copra that it has adopted, based upon scientific investigation and adopted by local chambers, trade boards, and trade conventions. The Bureau grades and their descriptions are:

Corriente. This grade is whiter and softer than *buen corriente* and contains a minimum moisture content of 14.5 to 18.8 per cent. It is artificially dried by means of smoke, air or stove drying. It is also called Laguna or Tayabas grade.

Buen corriente. This grade may be a Laguna or Tayabas copra stored in a warehouse and left there to dry for two or three weeks. It has at least 9 per cent moisture content.

Sun-dried, or asoleado. This grade is copra dried in the sun. It has at least an average of 7 per cent water.

Semi-resecada. This grade closely resembles the sun-dried. This copra may be dried either by sun, air or stove, but is generally of a better quality than the sun-dried.

Ex-godown. This grade is well-dried copra ready for milling, which has been stored in a warehouse.

RESULTS

The results of the investigation carried on in the provinces of Laguna and Tayabas regarding dimensions of the furnace, drying chambers, and grills of the different driers are given in table 1.

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[4] Outermost layer of the coconut meat that has been scraped off.

The data on the approximate cost of construction and capacity of the different driers and the materials of which they are made were gathered by making actual investigations and by inquiries from the owners and managers of the driers. The data are given in table 2.

The itemized cost of making copra from a thousand nuts by different methods was secured from interviews with the owners and managers of the driers. In some cases, like the sun-dried method in Tibiao, Antique, the writer sent a letter of inquiry to the Municipal President. In Los Baños, actual experiments were conducted with *tapahan* drying in June, 1928. The data are shown in table 3.

The period of drying, the moisture content of copra, and the average temperature of the *tapahan*, of the sun-dried in Los Baños and the new College copra drier were obtained by actual experiments. The results of the others under study were secured by careful investigation. The data are given in table 4.

The fresh meat and the copra placed in the gunny sacks were observed daily so as to find the length of time before mold appeared. The average daily temperature was secured from the Plant Physiology Department of the College of Agriculture. The data are shown in table 5.

The copra in the seven sacks was weighed on October 10, 16, and 22, 1928, to find the weekly loss in weight. At the time of weighing, samples of copra were taken to the Chemistry Department for moisture determination. The data are given in table 6.

The comparison of the profit from different methods was also studied and the results are tabulated in table 7.

The length of time before the appearance of mold on copra produced by different methods was observed and the data are given in tables 8, 9, 10, 11, 12, and 13.

DISCUSSION OF RESULTS

As may be seen in table 1, the furnace, drying chambers and grills in the different driers studied have different dimensions. The number of furnaces, drying chambers and grills varies according to the size of drier. In Santa Cruz the *tapahans* belonging to Mr. J. Valenzuela and to Mr. R. Tobias do not have the same number of furnaces, although they have the same number of drying chambers and grills. The drying chamber of Mr. Valenzuela's *tapahan* can accommodate as many as 20,000 nuts at a time, while that of Mr. Tobias is smaller. The layers of halved nuts in the Valenzuela drying chamber reach a height of 75 centimeters. It was observed that the bottom layer on the grill usually becomes somewhat burned. This may be due to the heat of the iron rods of which the grill is made.

The *tapahans* owned by Mr. S. Zalamea and Mr. V. J. Llamas, Jr., in Pagsanjan differ mainly in the number of furnaces and grills. Mr. Zalamea's drier is provided with two furnaces and two grills built side by side, while that of Mr. Llamas has one furnace and one grill.

In Sariaya the driers owned by Mr. F. Cadiz and Mr. T. de Gala have about the same form and construction, that is, if only one of de Gala's three driers is considered. The advantage of Mr. de Gala's drier over that of Mr. Cadiz is that the whole drier can hold at a time 3000 nuts more. Mr. Cadiz's drier is built the proper size for drying the production of a forty-hectare plantation; Mr. de Gala's drier for the production of forty thousand trees.

The smallest and oldest form of *tapahan* found in the investigation is that owned by Mrs. Amanda Cruz in Los Baños. The general view of this *tapahan* in actual operation is shown in figure 11. The *tapahan* is operated only when the local price of nuts ranges from ₱25 to ₱27 a thousand and the copra is around ₱10 a picul. This is about the lowest price obtaining in Los Baños.

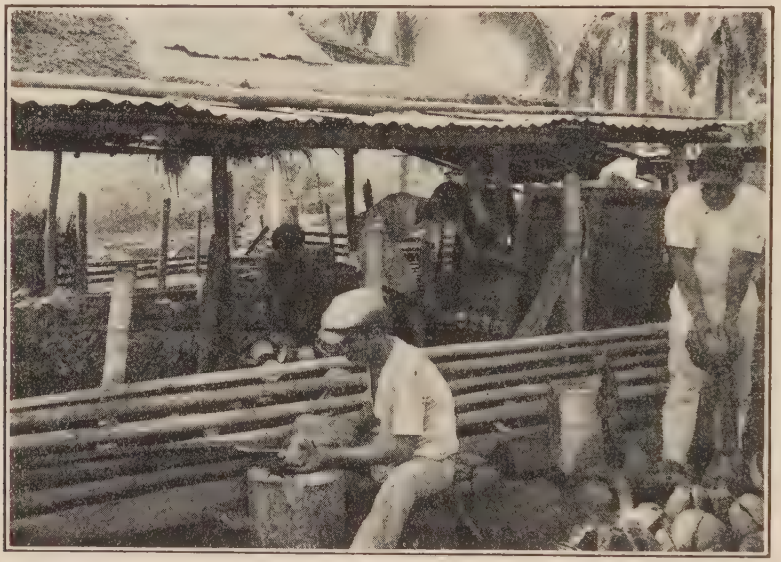

Fig. 1.—A General View of a Los Baños Tapahan.

The new College copra drier differs from the ordinary *tapahan* mainly in that it prevents the smoke from coming in contact with the copra so the product appears white.

The Franklin Baker Company drier is provided with a long endless conveyor which can be adjusted to any speed desired by means of a pulley connected to the main shaft. This conveyor constantly moves on at such a speed that the copra is dried to the desired extent when it reaches the other end. The drying is accomplished faster than in any of the other methods studied, because of the fans which drive out the moist air from the drying chamber.

A comparison of the approximate cost of construction, capacity, and materials of the different driers is given in table 2. The Franklin Baker Company's Dessicated Coconut Factory has the highest capacity, but the writer could not secure data on the cost of construction, yet this drier is undoubtedly the most expensive.

The new college copra drier is built of lumber, adobe rock, cement, and lime. This drier, according to the College of Agriculture Experiment Station Circular No. 11, costs ₱157, including conveyor. But in the opinion of the writer, it may cost about ₱257. This amount agrees with the estimate made by Mr. Joaquin R. de Arana, Farm Engineer of the College of Agriculture. Two men are required to operate this drier. It holds 500 nuts at a time and finishes the drying in eight to twelve hours. Experience has shown that for larger capacity, the conveyor would not work because of the difficulty of turning the handle.

Mr. Valenzuela's *tapahan* in Santa Cruz has the largest capacity among the *tapahans* studied. It cost about ₱700. The foundation, furnace and drying chamber are made of concrete; the drying trays are made of iron slats crossing both ways. Mr. Tobias' *tapahan* is constructed the same as Mr. Valenzuela's, but is much smaller, and requires only one-half as many persons to operate it.

The Zalamea and Llamas driers in Pagsanjan are similar in construction of the furnace, drying chamber, and tray, and are made of similar materials. Although the capacity of the Llamas drier is only one-half that of the Zalamea, the same number of persons is required to operate it. Both driers have been used the same length of time.

The Cruz drier in Los Baños is undoubtedly the cheapest of all investigated because the cost of the materials was practically nothing. The cost of building was ₱15. The capacity is 1200 nuts and it can easily be operated by one person. Drying takes one and a half days.

The *tapahan* owned by Mr. de Gala in Sariaya is really three driers placed side by side under one shed. Each drier has a capacity of 1500 nuts. Two laborers operate each drier. The length of the underground tunnel is four meters from the furnace to the drying chamber. The furnace is lower than the drying chamber.

In the Cadiz drier in Sariaya the depth of the furnace is 3 meters, while de Gala's is 1.9 meters. The cost of the Cadiz drier is ₱400; of de Gala's, ₱500. The capacity of the Cadiz drier is 1500 nuts. It turns out copra from fresh meat in five hours.

Table 3 shows the itemized cost of making copra per thousand nuts by the different driers. It may be seen from this table that the cost of husking in the two *tapahans* studied in Santa Cruz is the same. The cost of removing the meat, chopping and drying it is not the same. Valenzuela pays ₱2.60 a thousand nuts while Tobias pays only ₱2.50. But Tobias pays five centavos more per picul for sacking than Valenzuela. The average number of piculs produced in each drier is practically the same. The total cost of making copra varies from ₱3.97 to ₱4.07 per thousand nuts depending upon the size of the nuts and thickness of the meat. In most places, the cost of removing the meat, chopping and drying it are not considered as separate items.

In Pagsanjan, the cost of husking is 80 centavos per thousand, actual drying and chopping, ₱1.50 per thousand, and sacking 10 centavos per picul. The total cost of production varies from ₱2.65 to ₱2.70 This low cost of production is brought about by the low cost of husking, drying, shelling, and chopping.

With the Cruz *tapahan* the whole cost is ₱4.00 per thousand nuts. The cost of husking is ₱2.00. For the rest of the operation, including sacking, ₱2.00 is paid for labor.

In Sariaya the driers owned by Cadiz and de Gala produce copra at the same cost as in the Cruz *tapahan*, irrespective of the size of the nuts used. The cost of husking in Sariaya is the same as in Santa Cruz. The cost of operation from drying to sacking is higher than in any of the other *tapahans* studied. But the ordinary nuts here are found to produce as much as 4.3 piculs per thousand.

In answer to a letter of inquiry by the writer to the Municipal President of Tibiao, Antique, the following information was secured. Sun-drying as practiced in this town is quite different from the methods employed in Laguna. The nuts are not husked but are cut into halves with an ax. These halves are exposed to the sun. Then with a bolo the meat is taken out of the shell. The length of time of drying depends upon the condition of weather, but usually it takes four to five days or a week to produce well dried copra. The meat is put on *sawali*[5] while drying. It costs only ₱2.40 to dry the copra from a thousand nuts. The reason for the low cost of making sun-dried copra in Tibiao is the cheap labor. The nuts are about the same size as Laguna nuts. The copra produced by this method is probably the best on the market.

According to Roxas (1926) the new College copra drier can produce *buen corriente* copra at ₱2.50 per thousand nuts. This includes expenses from husking to sacking.

The Dessicated Coconut Factory produces copra mainly from parings. From parings of 1000 nuts 34.94 kilograms of copra (55 centavos a picul) are obtained. The production cost is doubtless very low, but no accurate data were obtainable owing to the firm's policy of secrecy.

The period of drying, moisture content of copra, and average temperature under which the coconut meat was dried, were carefully studied and the results are given in table 4.

From this table, it my be seen that in the first drying in the sun at 28.1°C. practically 50 per cent of moisture content was dried off. During the subsequent days of drying there is a tendency for the coconut meat to lose less moisture as the drying progresses.

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[5] A mat woven from split bamboo stems.

From the *tapahan* in Los Baños, two samples were taken, one after three hours of drying and another after four hours of drying. The meat at these periods of drying was still attached to the shell but ready to separate. Usually, the temperature of the *tapahan* at this period is 90°C. The moisture content after three hours drying is 25.87 per cent and 25.11 per cent after four hours, practically the same. Samples after seven hours and eight hours of drying were taken for moisture determination and for observation in storage. The average temperature of the *tapahan* is 68.5°C. The copra from the eight-hour drying gave higher percentages of moisture than that of the seven hours. This indicates that the drying in the different parts of the *tapahan* is not uniform.

In Santa Cruz, the temperature of the *tapahan* varies from 60° to 90°C. from start to finish. The copra after twelve hours contained for two samples 9.18 per cent and 10.37 per cent moisture.

In Pagsanjan, the temperature of the *tapahan* is the same as that of Santa Cruz. The moisture content of the samples taken was practically the same as that of Santa Cruz.

In Sariaya the finished product from five hours of drying gave an average of 12.92 per cent and 14.85 per cent of moisture.

The Dessicated Coconut Factory which can maintain its temperature at 80°C. can turn parings into copra in 45 minutes, with moisture content of 7.53 per cent. For the entire meat 22 hours of drying are required, but the meat is dried at a much lower temperature; the moisture content after drying is 6.60 per cent.

The new College copra drier, with an average temperature of 70°C. can produce copra containing 14 per cent of moisture in about twelve and a half hours.

The length of time before mold appeared on fresh meat and copra produced by different methods is given in table 5.

It was three days before mold appeared on the fresh meat. In the case of sun-dried copra, the less moisture there is in the copra, the longer the time before mold appeared. It was 28 days before sun-dried copra having 8.02 per cent of moisture, stored at an average temperature of 30°C., was affected by mold. This test was made during summer when the relative humidity is low and was able to maintain a moisture content on copra of about 8 per cent. This finding corroborated the result of Lava's (1928) work.

There was mold on the product of the *tapahan* in Los Baños after five days. This copra contains moisture varying from 12.82 to 25.87 per cent. The average daily temperature where the observation was carried on was lower than in summer days, and the relative humidity was high.

In Santa Cruz, it is to be noted that the copra containing 9.18 per cent moisture, at a temperature of 28.2°C., was attacked by mold after three days. But in another case, copra containing 10.37 per cent moisture remained six days before it was attacked by mold. The temperature in the latter case is 0.1°C. lower than that of the former.

In Pagsanjan, the longest time before mold appeared on copra produced by the *tapahan* was six days; the moisture being 9.79 per cent and the temperature 28.1°C. It may be that the average relative humidity was quite low during that time.

In Sariaya, the copra with 12.92 per cent moisture, at a temperature of 26.9°C. kept one week without mold.

In San Pablo, in spite of the short time required in the production of paring copra by the Dessicated Coconut Factory, this kept for 11 days without appearance of mold. The other kind of copra from this factory kept for 14 days without being affected by mold.

The weekly loss in weight of the copra and loss in moisture by direct determination are given in table 6.

Of the 251.70 kilograms of copra placed in gunny sacks used in determining the weekly drop in moisture content while in storage, the loss of moisture was 6.86 per cent the first week and 12.25 per cent in the second week. In order to obtain *buen corriente* price, all the copra was stored for two weeks. In the first week there was a loss of weight of 17.30 kilograms and in the second week, 30.85 kilograms. Considering the copra stored after two weeks the moisture content being 7.48 per cent to be *buen corriente* and price ₱16.77 per 100 kilograms and comparing it with that of the *corriente*, with price at ₱15.82 per 100 kilograms, the *corriente* is worth ₱2.78 more than the *buen corriente*. Obviously the producer loses by storing his copra before selling it locally. It was also noticed that the temperature of the copra in the sack was very much higher the first week than the second. The outside temperature ranged from 30°C. to 37°C. and the inside from 37°C. to as high as 41°C. It is evident that it is during the first week of storage that the most active decomposition of the copra takes place.

Profits in making copra from the different driers are given in table 7. No comparison can be given because the methods are under different labor conditions and prices of nuts. However, for purposes of getting the relative efficiency of each method under the conditions where they are practiced, the table is given. Because there was no sample received from Tibiao, Antique, the average moisture content could not be determined, but the *asoleado* may command as high a price as the *buen corriente*. The price of the coconut prevailing in Tibiao is ₱25 per thousand, and labor is quite cheap. The average cost of production of copra from 1000 nuts amounts to ₱28.60 including cost of the nuts. It was calculated based on experience in Tibiao that 1000 nuts can produce copra weighing 210.45 kilograms. Taking ₱10.60 as the price per picul of the copra or ₱16.77 per 100 kilograms, there would be a gain of ₱6.69. In the College of Agriculture the profit in making copra by sun-drying is only ₱4.29, owing to high cost of labor and price of nuts.

The *tapahan* in Los Baños shows a gain of 99 centavos per 1000 nuts. This low profit may be explained by the small yield of copra of the Los Baños nuts and the high cost of labor, which is ₱4 per 1000 nuts. If the price of nuts in Los Baños were as low as ₱25 or ₱27 a fair profit would be realized. Usually good profit is obtained when three very small nuts are counted as two in selling on the unit basis as is done many times.

The *tapahan* in Santa Cruz, although turning out copra containing 9.77 per cent moisture, sells its copra as *corriente* because the copra milling companies which buy copra there pay only the price of *buen corriente* when the copra has been stored in the *bodega* for several weeks. It has been calculated that a profit of only 77 centavos can be realized on 1000 nuts of average size, at the current price of ₱32 in Santa Cruz. The average cost of making copra from 1000 nuts and preparing it ready for market is ₱4.02

In Sariaya, the copra produced is also *corriente.* The profit is about twice as much as in Los Baños and about three times as much as in Santa Cruz. Evidently the reason for this is the higher yield of copra per 1000 nuts in Sariaya than in Santa Cruz or Los Baños, although the price of the nuts in Sariaya is ₱4 higher than in Santa Cruz or Pagsanjan. The cost of production in Sariaya is as high as in Los Baños. Nuts of average size yield 4.3 piculs or 271.76 kilograms of copra per 1000.

The *tapahan* in Pagsanjan gives more profit than that in Santa Cruz, Sariaya, or Los Baños, which is ₱2.86, although the average quantity of copra produced from 1000 nuts weighs about as much as that of Santa Cruz and is lower than that of Sariaya. The cost of making copra, which is only ₱2.65, is the item responsible for this profit.

The Dessicated Coconut Factory is the only drier that sells its product as *buen corriente*; that is probably because of the uniformity of drying and low percentage of moisture left in the copra. The average moisture content is only 7.53 per cent, this being the lowest of the copra studied. Of a husked coconut only one per cent is parings used for copra.

The new College copra drier gives a profit of ₱2.69 which is about the same as that of the *tapahan* in Pagsanjan. The average cost of making copra is ₱2.50 per thousand and the average cost of nuts in Los Baños is ₱28, so that the total cost amounts to ₱30.50. The copra produced by this drier is clean and white because of the exclusion of the smoke.

Tables 8, 9, 10, 11, 12, and 13 show the length of time in storage before the appearance of different kinds of molds on copra produced by different driers[6]. It is evident, in most of these results, that the white mold started first, being followed a few days later by the black, yellow, and green molds in sequence named. In some cases, however, this was not the order (see table 8). The reason for this is that drying of coconut meat was improperly done. In sun-dried copra, the black, yellow, and green molds appeared about the same time. It was observed that this copra kept longer without mold, than any other with about the same moisture content produced by other methods under study. This may be because it was observed in summer when the relative humidity was very much lower than in the months of June and September. It was observed further that the growth of all the molds was unevenly distributed on the surface area of the meat. The probable cause was the uneven drying of the samples used. As the time of storing was prolonged, the infected area became larger and larger until the whole meat was completely covered. A few days later the green mold became the dominating color, and as the copra became older and older, the mold turned to an ashy dust color. At this stage, the appearance of many larvae and small beetles inside the thick dry mold was observed. These insects were commonly found in copra containing as high as 25 per cent moisture. The small beetles probably find this molded copra a good breeding place. As the mold grows thicker and thicker they eat up the inner portion of the meat.

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[6] The writer did not make any attempt to identify the molds, but, according to Cox (1917), they are as follows: white mold, *Rhizopus* sp.; black, *Aspergillus niger* Van Tiegh; yellow, *Aspergillus flavus* Link; and green, *Penicillium glaucum* Link.

SUMMARY OF CONCLUSIONS

1. Of the *tapahan* methods studied, the Sariaya drier shows an improvement over the Laguna and the ordinary Tayabas types in the construction of the long underground tunnel.

2. The Tayabas type of *tapahan* produces copra in a much shorter time than the Laguna type.

3. The cost of production of copra in Laguna type varies from ₱2.65 to ₱4.07 per 1000 nuts and in that of Tayabas is ₱4.

4. Sun-dried copra keeps longer in storage without being affected by mold than the copra produced by any of the other methods studied.

5. The sun-drying method requires a much longer time to make copra than any of the other methods studied, produces the best copra, and gives the largest profit if the weather conditions are favorable.

6. The new College copra drier gives a larger profit than the Los Baños *tapahan*.

7. The Dessicated Coconut Factory turns out copra having 7.53 per cent moisture in 45 minutes.

8. The yield of copra produced from the average sized coconuts in Tayabas is generally greater than from the Laguna nuts.

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TABLE 1

Dimensions of the different driers studied

OWNER	PLACE	FURNACES				DRYING CHAMBERS				GRILLS			REMARKS
		NUMBER	DIMENSIONS			NUMBER	DIMENSIONS			NUMBER	DIMENSIONS		
			Width	Length	Depth		Width	Length	Depth		Width	Length	
			m.	*m.*	*m.*		*m.*	*m.*	*m.*		*m.*	*m.*	
J. Valenzuela	Sta. Cruz, Lag.	4	1.25	3.00	1.50	2	5.00	6.00	0.75	2	4.55	5.40	
R. Tobias	Sta. Cruz, Lag.	2	1.00	2.00	1.50	2	3.50	7.50	0.30	2	5.20	7.20	
S. Zalamea	Pagsanjan, Lag.	2	0.30	2.00	1.50	2	3.70	9.00	0.30	2	3.40	8.60	
V. J. Llamas, Jr.	Pagsanjan, Lag.	1	0.30	2.00	1.50	1	4.00	9.00	0.30	1	3.70	8.70	
F. Cadiz	Sariaya, Tay.	1	0.80	0.90	3.00	1	2.30	3.54	0.50	1	2.08	3.39	With 4 meters underground tunnel.
T. de Gala	Sariaya, Tay.	3	0.80	0.83	1.90	3	1.55	4.00	—	6	1.55	4.00	With 4 meters underground tunnel.
A. Cruz	Los Baños, Lag.	1	0.95	0.92	2.00	1	1.96	3.60	0.20	1	1.40	3.12	
College of Agriculture	Los Baños, Lag.	1	0.70	1.25	1.15	2	1.10 1.10	3.70 2.58	0.30 —	2	1.00[a] 1.00[b]	3.70	Provided with endless conveyor.
Franklin Baker Co.	San Pablo, Lag.		Exhaust steam			1	2.00	15.00	3.00	1	2.00	15.00	Provided with endless conveyor.

[a] Heating chamber.

[b] Preheating chamber.

TABLE 2

Data on different driers

DRIER	OWNER	MATERIALS USED			APPROXIMATE COST	NO. PERSONS REQUIRED DURING OPERATION	LOADING CAPACITY IN NUTS	APPROXIMATE LENGTH OF TIME[a] TO PRODUCE COPRA
		Furnace	Drying chamber	Grill				
					pesos		*number*	*hours*
Tapahan.............	Valenzuela	Concrete	Concrete	Interwoven iron	700.00	6	15,000 to 20,000	48
Tapahan.............	Tobias	Concrete	Concrete	Interwoven iron	500.00	3	12,000	48
Tapahan.............	Zalamea	Adobe rock in ladder form	Concrete	Buñga[b] and coconut stems	300.00	3	18,000	48
Tapahan.............	Llamas, Jr.	Adobe rock in ladder form	Concrete	Buñga and coconut stems	200.00	3	9,000	48
Tapahan.............	Cruz	Ground	Ground	Buñga and coconut stems	15.00	1	1,200	36
Improved tapahan.....	Cadiz	Concrete	Concrete	Fastened iron rods with wheels	400.00	2	1,500	5
Improved tapahan.....	De Gala	Concrete	Concrete	Fastened iron rods with wheels	1500.00	6	4,500	7
Dessicated Coconut Factory............	Franklin Baker Company	Exhaust steam pipe	Steel and iron	Endless metallic conveyor	Not given	3	Parings from 95,000	¾
New College copra drier	College of Agriculture, U. P.	Lime, adobe rock and cement	Lime, adobe rock and cement	Galvanized iron sheet with endless conveyor	257.00[c]	2	500	8–12

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[a] Excluding the time consumed in husking.

[b] *Areca catechu.*

[c] Estimated by Mr. J. Ruiz de Arana, Farm Engineer of the College of Agriculture,

TABLE 3

Itemized costs of making copra from a thousand nuts by different methods

OWNER	GRADE	HUSKING	KILNING, CHOPPING, AND SHELLING	SACKING PER PICUL	AVE. NO. PICULS PRODUCED PER 1000 NUTS	SIZE OF NUTS	TOTAL COST
		pesos	*pesos*	*pesos*			*pesos*
J. Valenzuela	C[a]	1.00	2.60	0.10	3.80	large	3.98
J. Valenzuela	C	1.00	2.60	0.10	3.70	ordinary	3.97
R. Tobias	C	1.00	2.50	0.15	3.80	large	4.07
R. Tobias	C	1.00	2.50	0.15	3.60	ordinary	4.04
R. Tobias	C	1.00	2.50	0.15	3.50	small	4.03
S. Zalamea	C	0.80	1.50	0.10	4.00	large	2.70
S. Zalamea	C	0.80	1.50	0.10	3.50	ordinary	2.65
V. J. Llamas	C	0.80	1.50	0.10	3.50	ordinary	2.65
A. Cruz	C	2.00	2.00 including sacking		3.30	ordinary	4.00
A. Cruz	C	2.00	2.00 including sacking		3.50	large	4.00
F. Cadiz	C	1.00	3.00 including sacking		4.30	ordinary	4.00
F. Cadiz	C	1.00	3.00 including sacking		4.50	large	4.00
T. de Gala	C	1.00	3.00 including sacking		4.20	ordinary	4.00
N. Amarillo	A[b]	——	1 20 cutting and shelling		3.33	ordinary (Laguna)	4.00
Col. of Agri	C	2.50 up to sacking			3.32	ordinary	2.50
Franklin Baker Co.	B.C.[c]	——	——	——	0.55	ordinary	undetermined

[a] *corriente*
[b] *asoleado*
[c] *buen corriente*

TABLE 4

Period of drying, moisture content of copra, and average temperature under which the coconut meat was dried

PLACE	METHOD	PERIOD OF DRYING	AVERAGE TEMPERATURE	AVERAGE MOISTURE CONTENT (WET BASIS)	REMARKS
				per cent	
Los Baños, Laguna...	Sun-drying	Fresh meat	——	53	Summer, 1927
Los Baños, Laguna...	Sun-drying	1 day	28.1° C.	26	Summer, 1927
Los Baños, Laguna...	Sun-drying	2 days	28.4° C.	20	Summer, 1927
Los Baños, Laguna...	Sun-drying	3 days	28.9° C.	10	Summer, 1927
Los Baños, Laguna...	Sun-drying	4 days	29.0° C.	8	Summer, 1927
Los Baños, Laguna...	Sun-drying	5 days	29.2° C.	4	Summer, 1927
Tibiao, Antique......	Sun-drying	4–5 days	31.0° C.	——	No sample received
Los Baños, Laguna...	Tapahan	3 hours	90.0° C.	25	Starting point
Los Baños, Laguna...	Tapahan	4 hours	90.0° C.	25	Starting point
Los Baños, Laguna...	Tapahan	7 hours	68.5° C.	12	Finishing point
Los Baños, Laguna...	Tapahan	7 hours	68.5° C.	13	Finishing point
Los Baños, Laguna...	Tapahan	8 hours	68.5° C.	18	Finishing point
Los Baños, Laguna...	Tapahan	8 hours	68.5° C.	20	Finishing point
Los Baños, Laguna...	Tapahan	8 hours	68.5° C.	17	Finishing point
Sta. Cruz, Laguna....	Tapahan	12 hours	75.0° C.	9	From start to finish
Sta. Cruz, Laguna....	Tapahan	12 hours	75.0° C.	10	From start to finish
Pagsanjan, Laguna...	Tapahan	12 hours	75.0° C.	9	From start to finish
Pagsanjan, Laguna...	Tapahan	12 hours	75.0° C.	10	From start to finish
Pagsanjan, Laguna...	Tapahan	12 hours	75.0° C.	12	From start to finish
Pagsanjan, Laguna...	Tapahan	12 hours	75.0° C.	11	From start to finish
Sariaya, Tayabas.....	Tapahan	5 hours	80.0° C.	12	From start to finish
Sariaya, Tayabas.....	Tapahan	5 hours	80.0° C.	14	From start to finish
San Pablo, Laguna...	Dessicated Coconut Factory	45 min.[a]	80.0° C.	7	From start to finish
San Pablo, Laguna...	Dessicated Coconut Factory	22 hours	——	6.60	From start to finish
College of Agriculture.	New College copra drier	12½ hours.	70.0° C.	14.00	From start to finish

[a] Copra parings.

TABLE 5

Length of time before mold appeared on fresh meat and copra produced by different methods

PLACE	METHOD	AVERAGE MOISTURE CONTENT	AVERAGE DAILY TEMPERATURE	LENGTH OF TIME BEFORE MOLD APPEARED
		per cent		*days*
Los Baños	Sun-dried	53.19	28.9° C.	3
Los Baños	Sun-dried	26.85	29.8° C.	7
Los Baños	Sun-dried	20.75	29.8° C.	8
Los Baños	Sun-dried	10.79	29.9° C.	13
Los Baños	Sun-dried	8.02	30.0° C.	28
Los Baños	Tapahan	25.87	28.0° C.	3
Los Baños	Tapahan	25.11	27.4° C.	2
Los Baños	Tapahan	12.82	27.5° C.	5
Los Baños	Tapahan	13.72	27.6° C.	4
Los Baños	Tapahan	18.06	28.0° C.	3
Los Baños	Tapahan	20.37	28.0° C.	3
Los Baños	Tapahan	17.73	27.6° C.	5
Santa Cruz	Tapahan	9.18	28.2° C.	3
Santa Cruz	Tapahan	10.37	28.1° C.	6
Pagsanjan	Tapahan	9.79	28.0° C.	6
Pagsanjan	Tapahan	10.85	28.1° C.	5
Pagsanjan	Tapahan	12.40	28.1° C.	5
Pagsanjan	Tapahan	11.19	28.1° C.	5
Sariaya	Tapahan	12.92	26.9° C.	6
Sariaya	Tapahan	14.85	27.0° C.	4
San Pablo	Dessicated Coconut Factory	7.53	27.4° C.	11
San Pablo	Dessicated Coconut Factory	6.60	27.4° C.	14

TABLE 6

Weekly loss in weight and in moisture of the copra in storage by direct determination

SACK NO.	OCTOBER 10, 1928	INITIAL MOISTURE CONTENT (AVERAGE)	OCTOBER 16, 1928	MOISTURE CONTENT (AVERAGE)	OCTOBER 22, 1928	AVE. MOISTURE CONTENT
	Initial weight		Loss in weight		Loss in weight	
	kg.	*per cent*	*kg.*	*per cent*	*kg.*	*per cent*
1	64.00	17.04	5.10	9.18	9.50	7.48
2	62.90	17.04	4.50	9.18	9.50	7.48
3	47.90	17.04	3.00	9.18	4.10	7.48
4	28.75	17.04	1.00	9.18	2.40	7.48
5	27.05	17.04	2.40	9.18	3.05	7.48
6	6.25	17.04	0.20	9.18	0.45	7.48
7	14.85	17.04	1.10	9.18	1.85	7.48
Total	251.70		17.30		30.85	
Per cent			6.86		12.25	

TABLE 7

Comparison of profits from different methods

METHODS	AVE. MOISTURE CONTENT	GRADE	AVE. WEIGHT OF COPRA PER 1000 NUTS	MARKET PRICE PER 100 KG. OF COPRA	VALUE OF 1000 NUTS MADE INTO COPRA	AVE. COST OF MAKING COPRA PER 1000 NUTS	AVE. PRICE PER 1000 NUTS	TOTAL AVERAGE COST PER 1000 NUTS	PROFIT
	per cent		*kg.*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*	
Sun-dried Tibiao, Antique	—	Asoleado	210.45	16.77	35.29	3.60	25.00	28.60	6.69
Sun-dried Los Baños, Laguna	10.70	Asoleado	210.45	16.77	35.29	3.00	28.00	31.00	4.29
Tapahan Los Baños, Laguna	20.81	C[a]	208.56	15.82	32.99	4.00	28.00	32.00	0.99
Tapahan Santa Cruz, Laguna	9.77	C	232.57	15.82	36.79	4.02	32.00	36.02	0.77
Tapahan Sariaya, Tayabas	13.88	C	271.76	15.82	43.99	4.00	38.00	42.00	1.99
Tapahan Pagsanjan, Laguna	11.05	C	237.10	15.82	37.51	2.65	32.00	34.65	2.86
Dessicated Coconut Factory, San Pablo, Laguna	7.53	B.C.[b]	34.94	16.77	5.85	—	3.20[c]	—	Undetermined
New College Copra Drier, College of Agriculture	22.00	C	209.82	15.82	33.19	2.50	28.00	30.50	2.69

[a] *corriente*

[b] *buen corriente*

[c] One per cent of the cost of the nut is charged.

TABLE 8

Length of time before appearance of molds on sun-dried copra

DATE OF SAMPLING	MOISTURE CONTENT	WHITE MOLD	BLACK MOLD	YELLOW MOLD	GREEN MOLD	REMARKS
1927	*per cent*	*days*	*days*	*days*	*days*	
April 6	53.19	3	5	5	12	Slow and heavy molding[a]
April 6	26.85	7	9	7	15	Slow molding
April 7	20.75	8	9	9	9	Rapid growth of mold
April 8	10.79	13	13	15	21	Slow molding
April 9	8.02	28	31	31	49	Slight molding
April 10	4.21	46	49	49	67	Very slow growth of slight mold

[a] Fresh meat

TABLE 9

Length of time of appearance of molds on copra made by the Los Baños tapahan

DATE OF SAMPLING	MOISTURE CONTENT	WHITE MOLD	BLACK MOLD	YELLOW MOLD	GREEN MOLD	REMARKS
1928	*per cent*	*days*	*days*	*days*	*days*	
June 20	25.11	2	4	5	11	Rapid development of mold with slight rancidity.
June 21	12.82	5	8	12	17	Slow growth and not uniform.
June 21	13.72	4	9	14	17	Slow and not uniform growth.
June 21	17.73	5	6	8	19	Slow and not uniform growth.
June 20	20.37	3	7	11	15	Slow but distribution quite uniform.
June 20	25.87	3	4	5	10	Rapid and heavy molding.
June 20	18.06	3	5	7	14	Slow and not uniform growth.

TABLE 10

Length of time before appearance of mold on copra made by the Santa Cruz tapahan

DATE OF SAMPLING	MOISTURE CONTENT	WHITE MOLD	BLACK MOLD	YELLOW MOLD	GREEN MOLD	REMARKS
1928	*per cent*	*days*	*days*	*days*	*days*	
September 1	9.18	7	10	10	21	Slight molding.
September 1	10.37	6	10	13	20	Slight molding.

TABLE 11

Length of time before appearance of mold on copra made by the Pagsanjan tapahan

DATE OF SAMPLING	MOISTURE CONTENT	WHITE MOLD	BLACK MOLD	YELLOW MOLD	GREEN MOLD	REMARKS
1928	*per cent*	*days*	*days*	*days*	*days*	
September 2...	9.79	6	12	15	22	Very slow and not uniform growth.
September 2...	10.85	5	9	12	19	Very slow and not uniform growth.
September 2...	12.40	5	7	11	21	Gradual growth with slight rancid odor.
September 2...	11.19	5	8	15	20	Slow growth.

TABLE 12

Length of time before appearance of mold on copra made by Sariaya tapahan

DATE OF SAMPLING	MOISTURE CONTENT	WHITE MOLD	BLACK MOLD	YELLOW MOLD	GREEN MOLD	REMARKS
1928	*per cent*	*days*	*days*	*days*	*days*	
September 12..	12.92	6	9	9	17	Slow and scanty growth.
September 12..	14.85	4	7	10	17	Slow and scanty growth.

TABLE 13

Length of time before appearance of mold on copra made by the Dessicated Coconut Factory in San Pablo

DATE OF SAMPLING	MOISTURE CONTENT	WHITE MOLD	BLACK MOLD	YELLOW MOLD	GREEN MOLD	REMARKS
1928	*per cent*	*days*	*days*	*days*	*days*	
September 22...	7.53	11	18	18	28	Slow and uniform growth.
September 22...	6.60	14	19	29	33	Slow and uniform growth.

EXPLANATION OF PLATE 1

Fig. 1.—Top view of a Los Baños tapahan. *ct*, coconut trunk; *f*, furnace; *t*, tray, areca and coconut trunks.

Fig. 2.—Longitudinal section of a Los Baños tapahan. *ac*, areca trunk splits; *cf*, coconut trunks; *f*, furnace.

Fig. 3.—Front view of a Santa Cruz tapahan. *dc*, drying chamber; *f*, furnace.

Fig. 4.—Top view of a Santa Cruz tapahan. *dc*, drying chamber, concrete; *f*, furnace, concrete; *ti*,tray, iron slats.

Fig. 5.—Top view of a Pagsanjan tapahan. *ar*, adobe rock; *dc*, drying chamber, concrete; *f*, furnace; *g*, grill, areca and coconut trunks.

Fig. 6.—Longitudinal section of a Pagsanjan tapahan. *dc*, drying chamber.

Fig. 7.—Front view of a Sariaya tapahan. *dc*, drying chamber, concrete; *f*, furnace, concrete; *it*, iron tray.

Fig. 8.—Longitudinal section of a Sariaya type. *dc*, drying chamber, concrete; *f*, furnace, concrete; *it*, iron tray; *ut*, underground tunnel.

Fig. 9.—Side view of the new College copra drier. *ar*, adobe rock; *dc*, drying chamber; *do*, Dutch oven; *ph*, preheaters; *ss*, smoke stack.

Fig. 10.—Longitudinal section of the new College copra drier.

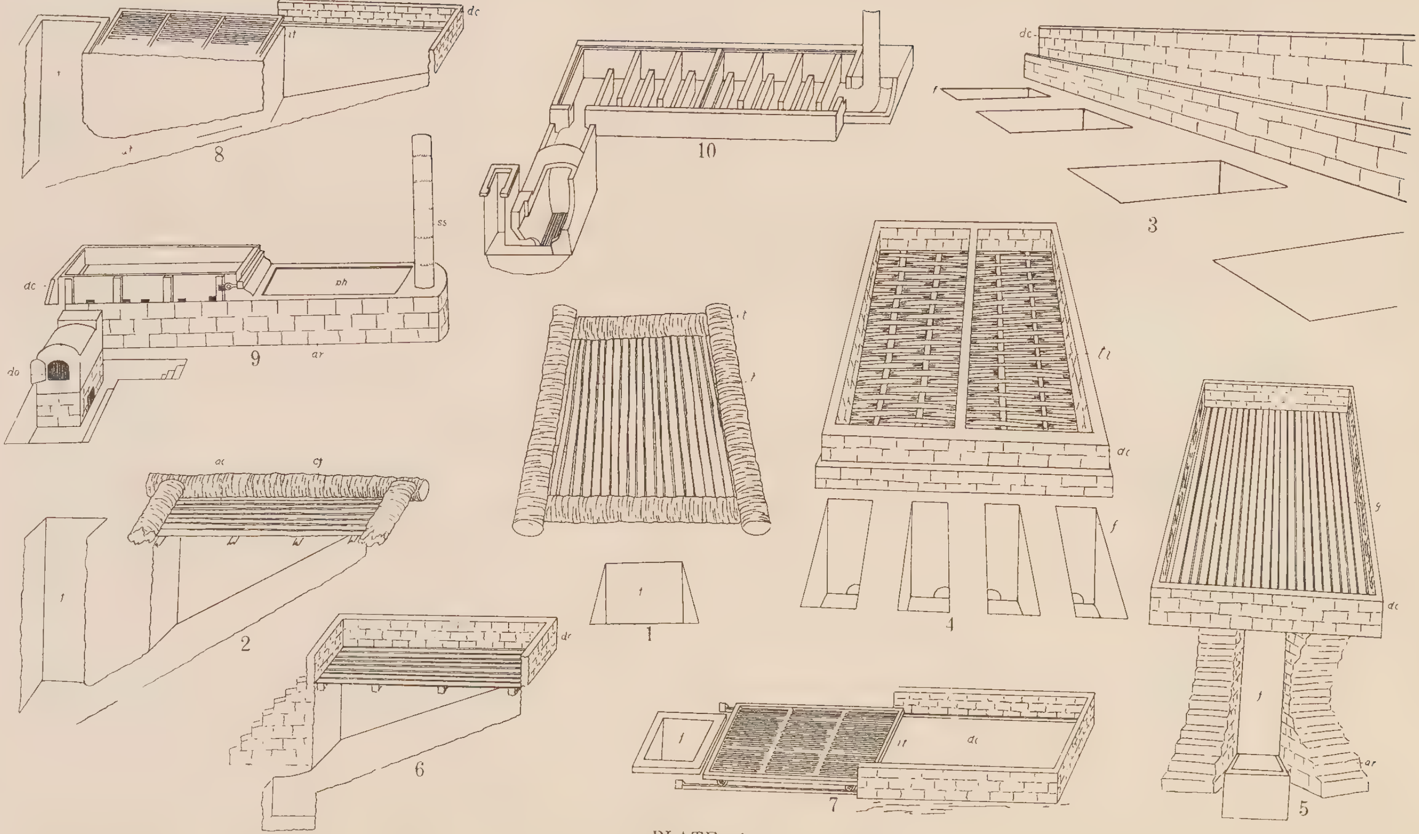
dc
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PLATE 1

COLLEGE AND ALUMNI NOTES

Dr. Charles E. Martin, professor of international law, Washington University, visiting lecturer at the University of the Philippines under the auspices of the Carnegie Foundation, delivered a convocation address at the College Auditorium on January 14. Doctor Martin was accompanied by Mrs. Martin and by Professor Conrado Benitez.

* * *

A banquet was tendered by the faculty of the Los Baños Colleges to Dr. Manuel L. Roxas on January 11 at the Molawin Hall, in honor of his accession to the post of director of the newly created Bureau of Plant Industry. The occasion was marked by a spirit of comradeship; and fun and merry-making lasted till the wee hours of the morning.

* * *

Mr. A. V. H. Hartendorp, editor of the *Philippine Magazine*, was guest on January 31 at a luncheon given by Dean Gonzalez at Molawin Hall. Secretary Fronda and Doctor Uichanco, who are occasional contributors to that publication, were also invited.

* * *

The first award from the Baker Memorial Fund has been granted to Ambrosio San Pedro, of Navotas, Rizal, a member of the Senior Class. Mr. San Pedro is a product of the public schools of his native province. He has worked his way through college, having served in succession as a student laborer and then as student assistant in the Departments of Animal Husbandry and Agronomy. He has been on the honor roll during the past two years. He is expecting to receive his B.S.Agr., Animal Husbandry Curriculum, in March.

* * *

The Secretary of the College has cooked up a new stunt for this year's graduating class. Senior singing will be indulged in for eight days—on February 23 and 26; March 2 and 6; March 9 and 12; and March 16 and 19. Seniors and resident alumni will be requested to wear caps and gowns during the last two days.

Cantonese chickens are being imported into Canton, China, their native home, from the College of Agriculture, Los Baños. As a result of years of selection, this College has improved and standardized our local stock of this breed. Professor Lester M. Zook, of Lingnan University, Canton, was sent to this College by that institution in the latter part of January to secure chickens of the Los Baños strain. In addition, he obtained a few of the College Berkjala hogs.

Under the joint direction of Miss Anne F. Cole and Mrs. Hugh Bousman, The Mimics, which is the College dramatic club, has commenced preparation on Gilbert and Sullivan's well-known light opera, "The Mikado," to be staged in July, 1930.

On February 1, Rev. and Mrs. Hugh Bousman entertained at the Manse in honor of Dr. Charles R. Hamilton, formerly pastor of the College Union Church, who has recently returned from the United States. Members of the faculty of the Los Baños Colleges accorded their old friend a hearty welcome.

The following papers were read at the fiftieth scientific meeting of the Los Baños Biological Club on January 30, 1930:

1. Dr. Miguel Manresa, Dean B. M. Gonzalez, Mr. Felix B. Sarao, and Mr. José P. Esguerra. Studies on the inheritance of coat colors and color patterns in crosses involving Philippine Native with Hereford and Nellore cattle. Preliminary report. Paper read by Doctor Manresa.
2. Dr. Anastasio L. Teodoro. The effect of compression ratio on the suitability of alcohol as a fuel for tractor engines.

The following summary of results of the 1929-1930 U. P. Los Baños Colleges Intramural Athletic League was prepared by Assistant Physical Director Ramon P. Tolentino, Jr.

By winning three out of five events, the College of Agriculture Sophomores (Class of 1932) duplicated their feat of last year and won in the 1929-1930 U. P. Los Baños Colleges Intramural Athletic League. The following is a complete summary of the League results and the prizes that will be awarded to the winning teams by C. Alkan, Inc.:

Teams	*Basket-ball*	*Volley-ball*	*Foot-ball*	*Relays*	*Track and field*	*Totals*	*Prizes*
1. C. A. Soph. ('32)	50	20	50	30	86	236	(Gen. Championship Cup; Football, Relay and Track and Field Pennants.)
2. C. A. Fresh. ('33)	60	60	45	8	24	197	(Basket-ball and Volley-ball Pennants.)
3. C. A. Seniors. ('30)	45	25	30	24	33	157	
4. Supplementary Preparatory-High Special	35	25	35	2	10	107	
5. Forestry	10	30	20	8	2½	70½	
6. Veterinary	20	40	0	2	1	63	
7. C. A. Juniors. ('31)	0	0	30	16	13½	59½	

For the first time since 1921, U. P. Unit IV (Los Baños Colleges) won the coveted University track and field championships at the meet which was held in Manila on January 18 and 19, 1930. The Aggies have always been strong contestants in this athletic event, but it was only this year that they were again able to win a glorious victory, an overwhelming one. Pedro Yatar, captain of Unit IV team, who, with 20 points to his credit, tied with Saberon of Unit III for highest individual point winning, was also responsible for the only two records broken in the meet—the time for both the 800- and 1,500-meter events. Guillermo Manalo and José Austria in the field events, and Pascual Andres, Amado Paggao, Eleuterio Enriquez, Leonardo Banaag, and José Zabarte, Jr., in the track events, contributed much to the Aggies' victory. The standing of the teams in the meet follows:

U. P. Unit IV (Los Baños Colleges)	70 ½ points
U. P. Unit I (Engineering, Law, Medicine)	40 points
U. P. Unit III (Education)	34 points
U. P. Unit II (Liberal Arts)	17 ½ points

The following obituary notice appeared in the *Journal of the American Veterinary Medical Association* **75:** 793. 1929—

Dr. Alonzo S. Shealy, of Augusta, Ga., died at a local hospital, October

24, 1929, after an illness dating back about three weeks. He was 56 years old.

After attending Clemson College, South Carolina, Dr. Shealy secured his veterinary training at Iowa State College. The following year he went to the Philippines to join the Bureau of Agriculture at Manila. Later he was connected with the Bureau of Science, in Manila, and the College of Veterinary Science at Los Baños. In 1925, he returned to the United States and located at Augusta, Ga., where he was assigned to duties with Richmond County.

According to advices recently received at this College, Mrs. J. Edgar Higgins died of heart failure on December 18, 1929, at Balboa, Canal Zone, Panama. Mr. and Mrs. Higgins were residents at the College for some time, while Professor Higgins was connected with the College of Agriculture as head of the Department of Agronomy.

THE EFFECT OF AMMONIUM SULFATE UPON THE GROWTH, HEIGHT, AND TILLERING OF YOUNG SUGAR-CANE SEEDLINGS

TORIBIO MERCADO AND JOSÉ A. SERRANO
Of the Department of Agronomy

WITH ONE TEXT FIGURE AND TWO CHARTS

Nursery care and treatment of sugar cane seedlings bear an important relation to the selection of desirable sugar-cane varieties. Lack of such care may cause the death of seedlings, which would otherwise survive and which might be subsequently selected. It is therefore very important that the seedlings be given the best aid, at least during the first year of vegetative development. Artificial means for minimizing the death, hastening the growth, and encouraging the production of tillers of the seedlings should be employed. The present paper reports the results of an experiment to determine the effect of ammonium sulfate upon the growth, height, and tillering of young sugar cane seedlings.

Time and place of the work

This work was performed in the old Plant Breeding garden of this College from the latter part of January to the end of June, 1929.

MATERIALS AND METHODS

The land used in this experiment had been planted to sugar cane since 1919. The land was divided into plots, which were prepared thoroughly. Each plot was 3 meters wide and 4 meters long. Some of the plots had been previously planted to *Vigna hosei* Backer (*V. oligosperma* Backer) and *Indigofera hendecaphylla* Jacq, two of the cover crops brought by Doctor Mendiola from Java.

The seedlings used

During the 1928-1929 cane breeding season sugar-cane seeds were collected and sown in the months of January and February. The thoroughly prepared plots were used for pricking the seedlings instead of boxes as practiced in previous years. Pricking was begun on the field early in March and was completed at the beginning of April. At the middle of March some of the seedlings had recovered from the effect of pricking, but the leaves were pale yellowish green and the seedlings had stunted growth. This led the writers to fertilize the seedlings.

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[1] Experiment Station contribution No. 597. Prepared in the Department of Agronomy under the direction of Dr. N. B. Mendiola.

THE PHILIPPINE AGRICULTURIST, VOL. XVIII, NO. 10, MARCH, 1930.

Fertilizing the seedlings

Three weeks after pricking, the seedlings recovered. When the seedlings were about thirty centimeters tall, ammonium sulfate was applied between the rows of seedlings at a depth of two centimeters and at the rate of two grams to a seedling. Half of each plot or each group of seedlings was fertilized and the other half was left as control. The fertilizer used was of old stock.

Measurements of the seedlings and other observations

When the effect of fertilizer was observed, measurement on the height of seedlings was begun and continued at weekly intervals for nine weeks until the seedlings were ready for transplanting.

The number of visible shoots found when the seedlings were first measured and also at transplanting time was taken. The number of seedlings with visible and invisible nodes in the fertilized and unfertilized plots was also recorded separately at the time of removing the seedlings from the nursery. The fertilized seedlings were planted in rows separately from the unfertilized ones. Living seedlings were counted a month after transplanting them to permanent fields.

RESULTS

The results of this experiment are given in charts 1 and 2 and in tables 1 to 4.

Chart 1 shows the comparative growth of the fertilized and unfertilized seedlings grown in plots previously planted to cover crops and the relative heights attained by them.

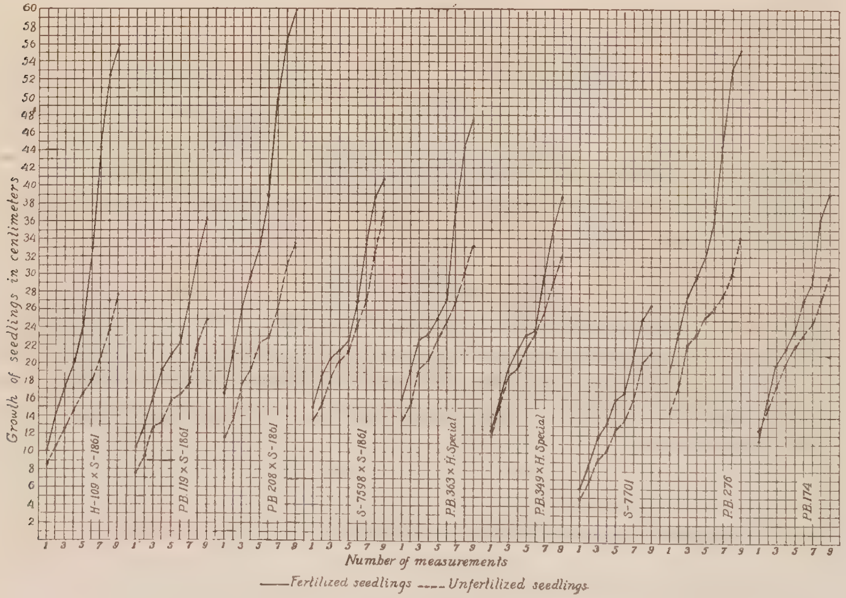

Chart 1.—Comparative Growth and Height of Fertilized and Unfertilized Seedlings Grown in Plots Previously Planted to Cover Crops.

Chart 2 shows the comparative growth of the fertilized and unfertilized seedlings grown in soils where no cover crop was grown previously and the relative heights attained by them.

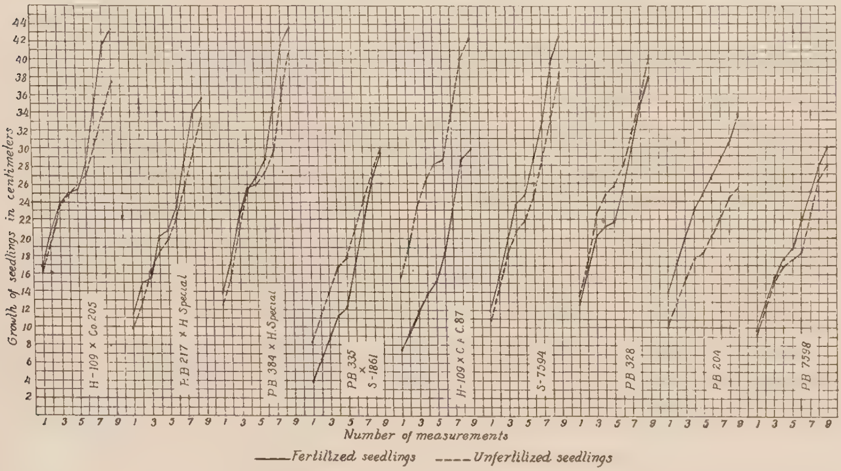

Chart 2.—Comparative Growth and Height of Fertilized and Unfertilized Seedlings Grown in Soils not Previously Planted to Cover Crops.

Table 1 gives the average growth of the seedlings showing the effect of ammonium sulfate.

Table 2 gives the comparative production of shoots at the start of the work and at the time for transplanting of the treated and untreated seedlings.

Table 3 shows the seedlings with visible and those without nodes of the fertilized seedlings and those grown as control.

Table 4 gives the percentage of seedlings which survived after planting them to permanent lots and treating them under field conditions.

DISCUSSION OF RESULTS

Pricking the seedlings in plots

Thoroughly prepared garden plots were found to be good media for pricking the sugar cane seedlings. Preparing the plots was more economical and less laborious than the preparaton of boxes, soil, and stands for the boxes. Seedlings in plots had more room for the development and expansion of the root system than those in boxes. The seedlings in plots were vigorous, while those in boxes had very stunted growth and very sickly appearance. One thing that should be noted, however, in pricking in plots is that the seedlings should be about five centimeters or more in height before pricking.

Growth and height of the seedlings

As shown in charts 1 and 2, there was a gradual growth of the seedlings in general during the first four weeks from early part of April to the middle part of May. About the latter part of May the growth of the seedlings was rather slow due to extreme heat during that time. Faster growth began after the first rain at the end of May.

Some of the seedlings in plots previously planted to cover crops did not show marked effect of ammonium sulfate (chart 1). Stunted growths were observed among the seedlings of (H-109×Co. 205), P. B. 217×Hind's Special, and (P. B. 384×Hind's Special). During the first four weeks the growth and height of the control seedlings were almost equal to those of the fertilized ones. However, at transplanting time the fertilized seedlings were taller than the control ones. The control seedlings of (P. B. 335×S-1861), (H-109×C. A. C. 87), and P. B. 328 grew faster and taller than the fertilized seedlings. Of the nine groups of seedlings planted in plots previously grown to cover crops only groups of seedlings of S-7594, P. B. 204, and S-7598 showed positive effects of the fertilizer.

These data show, therefore, that the application of fertilizer is unnecessary in fields previously grown to certain cover crops. Some seedlings planted in such plots were more vigorous than those in the fertilized plots.

On the other hand in poor soils ammonium sulfate affected the growth and height of the seedlings (chart 2). The fertilized seedlings were distinctly taller than the unfertilized ones. In some cases, particularly in those of the fertilized seedlings of (H-109× S-1861), (P. B. 208× S-1861), and P. B. 276, the fertilized ones were more than twice as tall as the control. (See figure 1.) In no case did the control seedlings attain the height of the

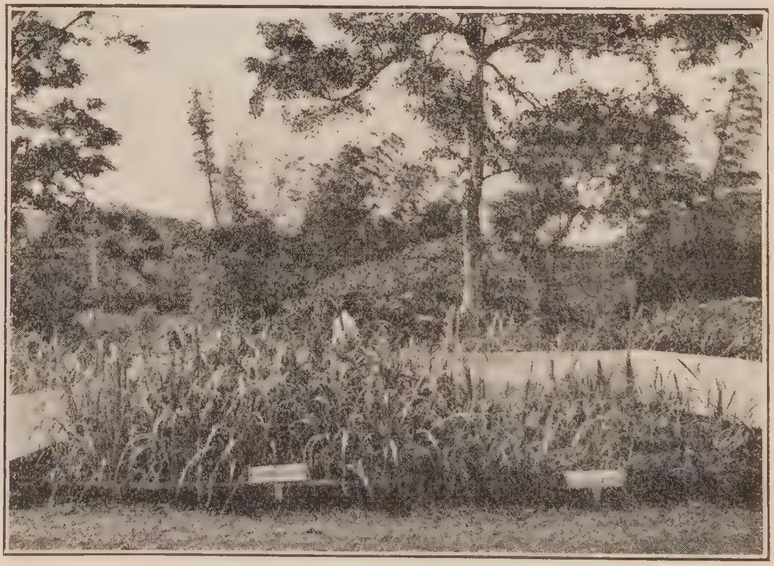

Fig. 1.—Sugar Cane (S-7637×S-1861) F_1 Hybrid Seedlings Showing The Effect of Ammonium Sulfate.

fertilized ones at transplanting time. It would be interesting to note that the seedlings of (P. B. 349×Hind's Special) which were planted in a plot previously saturated with water for over three months had almost the same height as those in the untreated plot during the first four weeks. This shows that saturation of the plots with water three months previous to planting the seedlings had some effect upon the growth and height of the seedlings. This is one of the probable causes of the rapid growth of the control seedlings.

As shown in table 1, there were measured 4,512 seedlings which were grown from fields not grown to cover crops previously, 2,254 of which were fertilized and the others were not. It will be seen that the fertilized seedlings had more growth than the unfertilized ones from the end of the first to that of the eighth week. The fertilized ones had an average growth of 3.54 ± 0.18 cm. during the first week; 7.11 ± 0.13 cm. the second week; 9.09 ± 1.29 cm, the third week; 12.51 ± 0.67 cm., the fourth week; 14.86 ± 1.05 cm., the fifth week; 22.76 ± 1.54 cm., the sixth week; 29.13 ± 1.72 cm., the seventh week; and 32.25 ± 1.91 cm., the eighth week. On the other hand the unfertilized ones had an average growth of 2.39 ± 0.13 cm. during the first week; 5.89 ± 0.25 cm., the second week; 7.09 ± 0.31 cm., the third week; 9.10 ± 0.09 cm., the fourth week; 10.64 ± 0.27 cm., the fifth week; 12.68 ± 0.44 cm., the sixth week; 16.23 ± 0.48 cm., the seventh week; and 19.30 ± 0.59 cm., the eighth week. The difference of the average weekly growth of the fertilized and unfertilized seedlings was very significant in favor of the fertilized plants.

Visible nodes in the fertilized and unfertilized seedlings. As shown in table 2, there were three different groups of hybrid seedlings and two groups of inbred ones under study. There was a total of 1,719 seedlings observed, 841 seedlings of which were fertilized and 878 seedlings were used as control. The production of visible nodes among the fertilized seedlings varied from 35.71 to 81.37 per cent. 65.86 per cent of the 841 fertilized seedlings had visible nodes while only 34.12 per cent had none at all. Both kinds of seedlings were healthy and greenish, the only difference between them being the absence of visible nodes. One to six visible nodes were observed among the fertilized seedlings. Only 174 of 878 unfertilized seedlings had visible nodes and the rest had none.

The fertilized seedlings were mostly healthy and ready for transplanting two months after pricking while the control seedlings remained thin and slender and appeared sickly. Most of the untreated ones grew so slow and some of them were so small that they were not ready for transplanting to permanent fields even four months after pricking.

These data clearly show that by the use of ammonium sulfate the production of nodes was encouraged and increased more than three times that of the control. Similarly the number of seedlings without visible nodes were reduced to less than one-half of the control seedlings.

Production of shoots

As shown in table 3, 3,425 seedlings were used for the study of shoot production. Most of them were hybrids while the rest were selfed. Each seedling of (H-109 × Co. 205), (H-109 × S-1861), P. B. 119 × S-1861), and (P. B. 208 × S-1861), had an average of only one shoot at the start of the experiment. At the end of the work or at transplanting time the fertilized seedlings had each from 3 to 5 shoots and those without fertilizer had from 1 to 2 shoots only, or an increase of from 50 to 400 per cent and from 0 to 200 per cent respectively. Control seedlings of (H-109 × S-1861), (S-7598 × S-1861), (P. B. 363 × Hind's Special), P. B. 296, and P. B. 174 had no increase at all. (H-109 × Co. 205), (P. B. 208 × S-1861), (P. B. 349 × Hind's Special), and S-7704 seedlings had an average increase of one shoot for each individual, and seedlings of (P. B. 119 × S-1861) had an average increase of 2 shoots for each plant. The rest of the seedlings had 2 shoots each at first but increased when fertilized. The majority of control seedlings had no increase at all. Of the 3,425 seedlings studied the fertilized seedlings gave an average increase of 150 per cent in each living stool. Of the control seedlings there was an average increase of only 37.5 per cent to a plant.

These data clearly show that by the use of ammonium sulfate the number of tillers of each plant of the varieties studied could be increased to 150 per cent when fertilized and only 37.5 per cent increase could be expected when unfertilized. The increase of the number of shoots of the fertilized seedlings was more than four times that of the control. The control seedlings usually produced no tillers at all.

Transplanting the fertilized and unfertilized seedlings. A month after transplanting to permanent fields the seedlings had assumed their normal growth. (See table 4). Of the 505 fertilized seedlings transplanted, 482 lived and 23 died. 95.45 per cent withstood transplanting. Only 4.76 per cent died. On the other hand 10.48 per cent of the 429 unfertilized seedlings transplanted died.

It will be noted that the death of the unfertilized seedlings was more than twice that of the fertilized ones when transplanted, hence less number of seedlings could reach maturity.

SUMMARY AND CONCLUSIONS

Ammonium sulfate used in this study had the following effects upon young sugar-cane seedlings:

1. The growth of the fertilized seedlings was faster than those of the unfertilized ones, rapid growth of the seedlings being observed after the first and subsequent rains. The leaves of the fertilized seedlings were dark green while the control were pale yellow.
2. The height of the treated seedlings was almost twice that of the untreated ones at the end of May.

3. The number of visible nodes as well as the size of the seedlings were increased considerably by the use of ammonium sulfate.

4. The fertilized seedlings produced more shoots than the unfertilized ones. Most of the untreated ones produced no tillers at all.

5. Seedlings planted in plots previously grown to cover crops showed neutral effect of fertilizer.

6. Fertilized seedlings withstood transplanting better than the unfertilized ones.

7. By the application of ammonium sulfate to young seedlings, the growth and size of stalks were encouraged while the unfertilized seedlings remained stunted and sickly even until the beginning of July when rain was abundant. When transplanted most of them could not resist the field conditions.

TABLE 1

Average growth of the seedlings showing the effect of ammonium sulfate

TREATMENT	NUMBER OF SEEDLINGS	AVERAGE GROWTH							
		1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	8th week
		cm.	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
Fertilized.....	2,254	3.54 ±0.18	7.11 ±0.13	9.09 ±1.29	12.51 ±0.67	14.86 ±1.05	22.76 ±1.54	29.13 ±1.72	32.25 ±1.91
Unfertilized...	2,258	2.39 ±0.13	5.89 ±0.25	7.09 ±0.31	9.10 ±0.09	10.64 ±0.27	12.68 ±0.44	16.23 ±0.48	19.30 ±0.59
Difference in favor of fertilized......		1.15 ±0.22	1.22 ±0.28	2.00 ±0.42	3.41 ±0.21	4.22 ±0.34	10.08 ±0.51	12.90 ±0.56	12.95 ±0.63

TABLE 2

Average production of shoots per plant

SEEDLINGS	NO. OF SEEDLINGS STUDIED	FERTILIZED				CONTROL			
		Initial count	Final count	Increase	Per cent increase	Initial count	Final count	Increase	Per cent increase
(H-109×Co. 205).....	565	1	3	2	200	1	2	1	100
(H-109×S-1861)......	450	1	3	2	200	1	1	0	0
(P.B. 119×S-1861)....	151	1	5	4	400	1	3	2	200
(P.B. 208×S-1861)....	109	1	3	2	200	1	2	1	100
(S-7589×S-1861)......	395	2	3	1	50	2	2	0	0
(P. B. 363 × Hind's Special............	80	2	4	2	100	2	2	0	0
(P. B. 349 × Hind's Special)...........	81	2	6	4	200	2	3	1	50
S-7704...............	605	2	5	3	150	2	3	1	50
P.B. 296.............	574	2	4	2	100	2	2	0	0
P.B. 174.............	415	2	4	2	100	2	2	0	0
Total................	13,425	16	40	24		16	22	6	
	342.5	1.6	4	2.4	170	1.6	2.2	.6	37.5

TABLE 3

Number of visible and invisible nodes in the fertilized and control seedlings

	FERTILIZED					CONTROL				
	FERTILIZED SEEDLINGS STUDIED	WITH VISIBLE NODES		WITHOUT VISIBLE NODES		CONTROL SEEDLINGS STUDIED	WITH VISIBLE NODES		WITHOUT VISIBLE NODES	
		Seedlings counted	Per cent	Seedlings counted	Per cent		Seedlings counted	Per cent	Seedlings counted	Per cent
(S-363 × Hind's Special)......	40	15	37.5	25	62.5	39	9	23.07	30	76.92
(S-7637×S-1861)	290	221	76.2	69	23.78	403	78	19.35	325	80.64
(H-109×S-1861)	204	166	81.37	38	18.62	136	30	22.05	106	77.94
S-7701.........	84	30	35.71	54	64.28	89	10	11.23	79	88.76
P.B. 147.......	223	122	54.7	101	45.29	211	47	22.27	164	77.72
Total..........	841	554	—	287	—	878	174	—	704	—
Average........	168.2	110.8	65.86	57.4	34.12	175.6	34.8	19.81	140.8	80.18

TABLE 4

Results of transplanting fertilized and unfertilized seedlings

FERTILIZED SEEDLINGS

	NO. OF SEEDLINGS	LIVING SEEDLINGS		DEAD SEEDLINGS	
		No.	Per cent	No.	Per cent
(P. B. 363×Hind's Special)...............	40	38	95.00	2	5.00
(S-7637×S-1861)........................	233	224	96.14	9	3.86
(H-109×S-1861).........................	232	220	94.83	12	5.17
Total..................................	505	482		23	
Average................................	168	161	95.45	8	4.76
UNFERTILIZED SEEDLINGS					
(P.B. 363×Hind's Special)...............	40	37	92.50	3	7.50
(S-7637×S-1861)........................	234	210	81.14	24	10.25
(H-109×S-1861).........................	155	138	89.03	17	10.97
Total..................................	419	385		44	
Average................................	143	128	89.54	15	10.48

A STUDY OF THE STANDARD OF LIVING IN THE TOWNS OF BALUNGAO AND SAN CARLOS, PANGASINAN[1]

ANSELMO AGBANLOG

WITH TWO CHARTS

Review of literature

In spite of its importance, the subject of standard of living has received very little attention in connection with the social and economic studies that have so far been made in this country. There is a dearth of literature on the standard of living in the Philippines. The Bureau of Labor has conducted several investigations on the cost of living in various provinces and in Manila, and found that the "budget of a family composed of two adults and three children for the year 1926 bears the following proportions: 59 per cent for food; 7 per cent for clothing; 11 per cent for rent; 6 per cent for fuel and light; 5 per cent for primary instruction; and 12 per cent for miscellaneous expenses".

It is interesting to compare this finding with those of similar studies made in various regions of the United States. Funk (1916) found in his investigation of 950 rural families in thirteen states of the Union that "the expenditure for food is 62 per cent; for fuel, 7 per cent; house rent, 31 per cent; and hired help in the house varies from 1 to 15 per cent".

Kirkpatrick, Atwater, and Bailey (1924) reported in their investigation of 402 families in rural districts of Livingstone County, New York, United States, the following proportion of family expenditures: 39.5 per cent for food; 13.9 per cent for clothing; 11.6 per cent for rent; 7.1 per cent for fuel; 6.2 per cent for operating expenses; 4.1 per cent for maintenance of health; personal, 1.2 per cent; and 0.6 per cent unclassified."

Kirkpatrick (1926) reported in his *Socio-Economic Study of 2,886 white farm families of selected localities in eleven states in the United States*, that the average expenditures are distributed as follows: "41.2 per cent for food; 14.7 per cent for clothing; 12.5 per cent for rent; 5.3 per cent for operation goods; 3.8 per cent for health; 6.6 per cent for advancement goods; and 2.6 per cent for life insurance."

The significant fact in these studies is that in spite of differences in conditions found in the areas covered, the results confirm the laws on family expenditures which Ernst Engle, a German economist, and formerly head of the Bureau of Statistics of the German Imperial Government, laid down as a result of an extensive study made by him on the standard of living in Germany. These laws are:

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[1] Thesis presented for graduation, 1928, with the degree of Bachelor of Agriculture from the College of Agriculture, No. 301; Experiment Station contribution, No. 631; Prepared in the Department of Rural Economics under the direction of Assistant Professor Mariano C. Lopez.

1. The greater the income, the smaller the relative percentage of outlay for subsistence.
2. The percentage of outlay for clothing is approximately the same whatever the income.
3. The percentage of outlay for lodging or rent, and for fuel and light, is invariably the same, whatever the income.
4. As the income increases in amount the percentage of outlay for sundries becomes greater.

Object of the present work

The object of this work was to study the standard of living of typical Filipino families in typical rural districts of the Philippines and to see whether the results of the study harmonize with Engle's laws. For this purpose, the towns of San Carlos and Balungao, province of Pangasinan, were selected. This study also includes an investigation of the socio-economic conditions of typical rural inhabitants, and whether such socio-economic conditions bear relation to their standard of living.

Period covered by the present work

The investigation was conducted during the academic year 1927-28.

METHODS OF THE SURVEY

Scope

The following phases are included in this study: Family income from different sources, such as farm income, including the value of farm products and live stock; labor income, which included the wages earned by members of the family and the money value of their labor on their own farms; household income, including income from household industries; and commercial income, like income derived from the buying and selling of goods, such as keeping a store and selling articles in the market. Family expenditures are classified as follows: farm expenses, composed of wages paid hired labor; family farm labor, animal labor, building repairs, seed, fertilizers, land taxes, and other expenses incurred in connection with the operation of the farm; household expenses, such as subsistence, clothing, lodging and rent, light and fuel, education, care of health, legal protection and social life.

The following miscellaneous social and economic phases of rural life are also included in the study: value of land and buildings; loans and interest; debts and interest; size of families; education of children; literacy of members of family; sanitary conditions of home and surroundings.

Questionnaires prepared in the Department of Rural Economics, College of Agriculture, were used in collecting the data. The information was obtained from a responsible member of the family—usually from the father or mother—but sometimes from the oldest child or from the most intelligent member of the family. One difficulty experienced by the writer was that the people were at first suspicious of the motive of the inquiry, so that it required considerable explanation and persuasion before they could be induced to give the information desired. However, when convinced of the innocence of the investigation, they willingly answered the questions, and, with the writer's familiarity with conditions in those localities, it is safe to say that the data here presented are reasonably accurate.

Data were secured from typical households. A total of 192 families were studied, of which 117 are from San Carlos and 75 from Balungao.

Area studied

In the selection of these two municipalities as the region for study, several points were considered. The province of Pangasinan, where these towns are located, is agricultural and its inhabitants are, therefore, mostly farmers. They are typical agricultural regions of the province. The social and economic conditions may safely be regarded as typical of several other municipalities of the province that the writer has visited.

Balungao is located in the southeastern part of Pangasinan; it is crossed by a first-class provincial road and a railway line. It produces such staple crops as rice, corn, sugar cane, tobacco, and minor crops, as vegetables and fruit.

San Carlos is located in the central part of the province and is crossed by first class provincial roads and the railway main line running from Manila to Bauang. Most of the principal Philippine crops, such as rice, corn, sugar cane, coconut, tobacco, also fruit and vegetables, are produced in the municipality.

Of the heads of the 75 families studied in Balungao, 93.3 per cent are farmers and small landowners. Of the heads of the 117 families studied in San Carlos 72.8 per cent are farmers and small landowners. The rest in both towns are merchants, professional men, or laborers.

The variation of the number of farmers in these two municipalities may be accounted for by the fact that the population of San Carlos is increasing, and the land owned by each family has become so small (a land holding being divided equally among the children) that no longer is there enough production to maintain the standard of living. For this reason families who are so affected quit farming and go into professions they believe will give yield enough to maintain their level of living.

Classification of family living

The question of classifying the family as to living, that is, the sources of family income and expenditures, is a rather difficult proposition. According to Kirkpatrick, "no thoroughly satisfactory scheme of classification of goods consumed in the household in general has yet been devised." The schedules used in this study contain the classification of the sources of income and expenditures of a family, and is considered to be very general and well adapted to the localities studied. The main groups of sources of income and expenditures are as follows:

- I Family income
    - 1. Farm income (includes crops and live stock)
    - 2. Labor income (includes wages for labor in the house and on the farm, and wages earned by members of family)
        - Farm operations
            - a. Seed bed preparations
            - b. Plowing the field
            - c. Harrowing the field
            - d. Pulling up seedlings
            - e. Planting
            - f. Harvesting
            - g. Pasturing animals,
        - Household operations
            - a. Daily housekeeping
            - b. Laundering
            - c. Repairing, house, utensils,
        - Employment
            - a. Teachers
            - b. Merchants
            - c. Clerks
            - d. Laborers
    - 3. Household income
        - a. Weaving baskets, mats, and hats
        - b. Embroidering
        - c. Weaving cloth
    - 4. Commercial income
        - a. Net profit derived from keeping store, or selling commodities in the market
- II Family expenditures
    - 1. Farm expenses
        - Hired labor, seeds, fertilizer, taxes,
    - 2. Family expenses[2]
        - a. Subsistence: includes all costs pertaining to food
        - b. Clothing: includes all expenses for wearing apparel
        - c. Rent: the monthly or yearly payment for the use of an occupied house and yard
        - d. Education: includes tuition fees, books, and all school supplies used

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[2] Light and disposal of sewage not included in this classification.

e. Care of health: includes fees paid to physicians, dentists, nurses, hospital services, and medicine
f. Social life: includes expenses for fiestas, weddings, dances, funerals, baptisms, picnics, liquor, tobacco, gambling,
g. Legal protection: includes attorney's fees, fees for legal documents, and fines

DISCUSSION OF RESULTS OF SOCIAL SURVEY

Family management

Table 1 shows that of the 117 families in San Carlos, 110 homes are managed by husbands as operators, and wives as housekeepers. Households run by married children independent of parents are considered as independent units. Five homes are managed by fathers as operators, with the eldest daughters as housekeepers; while two homes are operated by the oldest unmarried sons with mothers as housekeepers. In Balungao, 74 of the 75 families studied are managed by husbands as operators and by wives as housekeepers, and one home is managed by the oldest unmarried son with the mother as housekeeper.

Size of families according to number of children

The size of families is an important factor in this study because the determination of the cost of living should be based not only upon family income but also upon the size of the family. Table 2 gives the number of children in each family.

Size of families including all individuals

The size of family, including all members of the family, children not at home but directly supported by the family, and other individuals, such as relatives, domestics, and others living with the family, is shown in table 3.

The size of family including all children

The size of average households revealed in the survey was 6.1 persons in San Carlos and 5.1 persons in Balungao. According to the Census of the Philippine Islands for 1918, the average size of a household in the Philippines is 5.98 persons, and Royeca (1922) gives 4.71 persons for Calasiao, Pangasinan.

The average size of families, including the immediate members, as given by the Census of the Philippines for 1918, was 5.55 persons; Royeca (1922) gives 4.85 persons for Calasiao, Pangasinan, and the present survey gives 5.8 persons in San Carlos and 5.1 persons in Balungao.

Age

There is a total of 412 children in the 117 families in San Carlos, and 234 children in the 75 families in Balungao. These children fall under different age groups, ranging from below one year to 22 years or above. The distribution of these children among the different age groups both in San Carlos and Balungao is shown in table 4.

Schooling received by children

The amount of schooling received by the children of families covered by the study, both in San Carlos and Balungao, is shown in table 5.

Literacy of members of families

Table 6 shows the percentage of literacy in the area studied.

If a separate percentage is taken for each of the two foreign languages, English will receive a higher percentage than Spanish. This is because of the large number of children attending the public schools.

The figures on literacy from the Census of the Philippine Islands 1918, from the findings of Royeca (1922) in his study of tenancy in Calasiao, Pangasinan, and the data in this survey, are presented for comparison in table 7.

From the data in this table it may be seen that the literacy in native dialect in Balungao is higher than the percentage of literacy given by the Census for the Philippines, and by Royeca, whose investigation was limited to tenants in Calasiao, Pangasinan. In San Carlos it is lower than the census figures for the Philippines, but higher than Royeca's findings. The literacy in Spanish and in English shown by the survey is higher than that given in the Census for 1918 and in Royeca's report.

Health and sanitation

Most of the families studied have the Antipolo system for the disposal of sewage.[3]

The interior and exterior of the premises are generally kept clean and free from rubbish.

DISCUSSION OF RESULTS OF ECONOMIC SURVEY

Family income

The family income derived from the different sources, farm labor, household and commerce, with the increase in size of families by number of children are shown in table 8.

Family income includes cash received from all sources of income, as well as money value of family labor on the farm and in households.

The living income of a family is "the return from the efforts and time expended in terms of values, by individuals composing it". It is one of the vital limiting factors of a family in the satisfaction of wants. If the return from the different sources as farm, labor, household and commercial occupations of a family is small, the family must necessarily limit its wants and adjust its satisfaction of such wants to keep within that income.

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[3] Data on this item not taken.

It will be noted from the table that in both towns the size of family and family income do not correspond. In San Carlos, the average yearly income of a childless couple is higher than of those with one child; that of the family with only two children is higher than the income of families with three or four children; while the family with six children earns in a year more than the family with seven or more children.

In Balungao, the lack of co-ordination between size of family and earning capacity is even more notable. A family with five children has a smaller average yearly income than other smaller families, except a childless couple. A family with two children earns more than the families with three, four or five children.

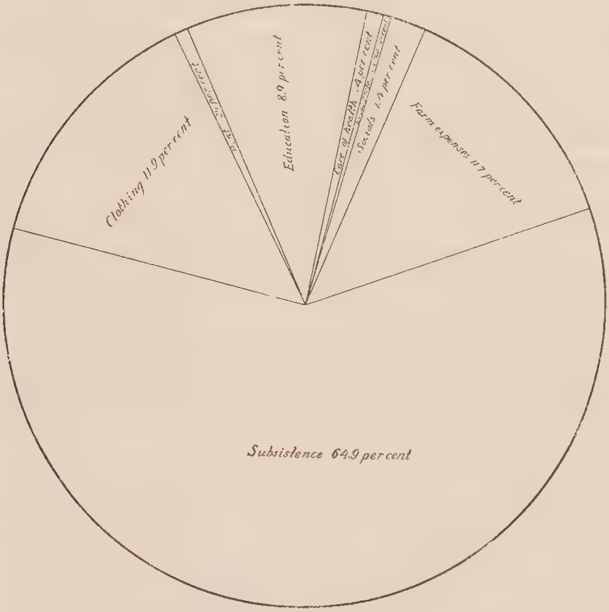

Chart 1.—Average Distribution of Cost of Living Among the Principal Groups of Goods Used by a Household during One Year in San Carlos, Pangasinan.

(Averaged from 117 families.) Total value of all goods used, ₱754.10; average size of household, 6.1 persons; average size of family, 5.8 persons.

The average yearly income in San Carlos is higher than in Balungao. This is explained by the fact that San Carlos has more commercial interests than Balungao, being a much larger municipality and with greater population.

The Balungao families pay very little attention to household industries and to merchandising. They are primarily farmers and wage earners.

Various reasons may be advanced for this lack of correlation between size of family and family income. The most important is the lack of appreciation by parents of the responsibility entailed in rearing children. Another reason is that the lack of amusement, means, and comforts of life in rural communities, lead these people to break the dreary monotony of life by contracting marriage at an early age. A comparative study of the ages at which rural and urban people marry reveals that the age in rural districts is much younger than in urban communities where there is greater variability in living conditions. This is a problem of great social significance and requires a separate and thorough study.

It will also be noted in the table that the largest percentage of the family income is derived from farm labor—higher than from other sources. This is explained by the fact that while the majority of the men are farmers and small landowners, yet they devote a part of their labor time to working for others—mostly among themselves—for which work they receive wages.

Relation of family according to number of children to expenditures

Table 9 shows the distribution of family expenditures among the various items of cost based upon the size of family according to number of children.

Relation of size of family to land value, income, and expenditures

Table 10 shows the average value of land owned by the family and average family income and expenditures according to size of family by number of children.

Relation of size of family to present value of house

The average present value of the house of a family in San Carlos is ₱297, and in Balungao, ₱135.

Table 11 shows the relation of size of family to the value of buildings.

Relation of size of family to family indebtedness

The average amount of debt per family in San Carlos is ₱3.47; and in Balungao, ₱15.00. Table 12 shows the relation of size of families to family indebtedness.

Cost of living

The family cost of living according to the different items of family expenses, by income groups, is shown by table 13.

The cost of living is that part of the income which is used by the family in the satisfaction of wants, which serves as an index to its standard of living. The average total value of all goods and services used by a family of 5.8 persons in San Carlos and a family of 5 persons in Balungao are shown in the charts.

These figures, with the data of a similar investigation by the Philippine Bureau of Labor, are given for comparison in table 14.

As shown by table 14, subsistence constitutes the highest outlay of expense in both surveys. The outlay for clothing is second in this study but third in the Bureau of Labor figures. The outlay for rent is negligible in the present survey, but second in the Bureau of Labor report. This may be due to the fact that the majority of the families studied in the present survey own their homes. There is a slight difference in the outlay for education in the two studies.

Table 15 shows the relative percentages of outlay for the various items of expenditures according to income groups of families.

The figures representing outlay for subsistece are in accordance with the findings by Ernst Engle, as well as by other investigators, that "as the income increases, the percentage of outlay for subsistence decreases."

The figures representing outlay for clothing seem to be at variance with Engle's law on clothing that the "percentage of outlay for clothing is the same, whatever the income." However, the variation for the outlay for clothing among the various income groups tends to agree rather than to contradict Engle's Law.

It is interesting to contrast the relative percentages of outlay for food and clothing in the two towns.

For clothing, the relative percentages of outlay do not closely conform to the income groups. It will also be noted that in some income groups, the percentage for clothing is higher than for other items, while in others it is lower. The same is true in Balungao. It is also interesting to note that while in San Carlos the percentage of outlay for food is higher in all income groups than in corresponding groups in Balungao, yet the latter has higher percentage of outlay for clothing than in San Carlos.

This is attested by the fact that the Balungao people appear better dressed than the San Carlos people, while the latter present better physical development than their Balungao neighbors. A careful observer will not fail to note this contrast.

Rent. In both towns most of the families included in this survey own their homes, so that the outlay for rent is negligible. The highest percentage of rent is that paid by the ₱600 to ₱1100 income group in Balungao, which amounts to 0.3 per cent of its total expenditures.

Education. The educational attainment of the members of a family is a reliable index to that family's economic standing, although of course there are exceptions to this. It may be asserted that a family capable of sending its children to school is on a higher economic level than one in which children are compelled to work for a living at an early age.

Care of health. In San Carlos, very little is spent by families for the care of health, that is, for physicians, dentists, oculists, and for medicine. All the 75 families in Balungao reported no expense for this purpose. The reason given is that common ailments are treated by "quack doctors", or *herbolarios*, who ask no fees nor gifts as reward for their services, except personal favors which are voluntarily extended to them in return. San Carlos, which has a population of about 40,000, has only two small drug stores, and even these, according to the owners, do not have a good business. There is no drug store in Balungao.

Legal protection. This constitutes a very insignificant item of family expenditure, an indication that the people in those localities are generally law-abiding. Court records in these towns show that a very few minor cases are tried, in practically all of which the services of attorneys are not needed.

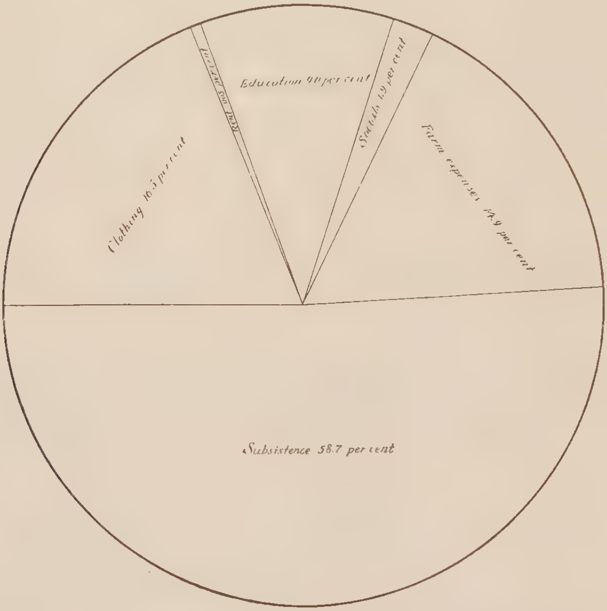

Chart 2.—Average Distribution of Cost of Living Among the Principal Groups of Goods Used by a Household during One Year in Balungao, Pangasinan.

(Averaged from 75 families.) Total value of all goods used, ₱493.32; average size of household, 5.1 persons; average size of family, 5 persons.

Social life. This item includes expenses for fiestas, dances, weddings, baptisms, funerals and vices, such as liquor drinking and gambling.

The results of the study show that both in San Carlos and Balungao families having moderate incomes have a liking for amusements. In San Carlos, families having an income of ₱600 or below, and ₱600 to ₱1100, can not indulge much in amusements for lack of means.

This analysis of sundry expenditures is in accordance with Engle's law that "as the income increases the percentage of outlay for sundries also increases."

This is particularly true in the case of education or cultural wants.

Comparison of income and cost of living by occupations

In this study four occupations were considered; namely, farmers; merchants, whose main source of livelihood is the selling and buying of goods; professionals, those who obtain their income from professional services such as clerks, and teachers, and laborers who obtain their living by manual labor.

Table 16 shows the relative income and expenditures for each family by occupation.

The farmers have an average income lower than any of the other occupations, as shown in this table. This is in accordance with the statement made by Boyle, "Agriculture is below par, when compared with other occupations."

He also states, "professions other than farming have higher income per unit capital and labor." The present survey shows that the farmer receives lower income than any of those engaged in the commercial or industrial occupations in those municipalities, in spite of the fact that the farmers have ready markets for their products and spend practically nothing in marketing them. In respect to expenditures, however, the farmers spend on the average more than the other occupation groups.

SUMMARY AND CONCLUSIONS

Social survey

1. Of the 117 families in San Carlos, 110 are managed by husbands and wives; five by fathers and eldest daughters; and two by oldest sons and mothers. Of the 75 families in Balungao, 74 are managed by husbands and wives; and one by son and mother.
2. The majority of the families in San Carlos have children ranging in age from 1 to 6 years; in Balungao, 12 to 21 years.
3. The average number of immediate members of families in San Carlos is 5.8 persons, and that of the entire households including all individuals in the family is 6.1, and in Balungao, the average size of families is 5.0 persons, and the entire household is composed of 5.1 persons.
4. In both places the majority of the children are not attending schools, or have not had the opportunity of doing so, and only about 33⅓ per cent of the children of school age are attending or have attended school.
5. In San Carlos, among the families covered, 28 per cent are literate in vernacular, and 22 per cent are literate in vernacular, English, and Spanish. In Balungao, 32.8 per cent are literate in vernacular and 17.1 per cent literate in vernacular, English, and Spanish.

Economic survey

1. Families in San Carlos and Balungao have a total average gross annual income of ₱1649.16, and ₱1449.67, respectively, including cash income and money value of family labor.

2. The average total annual expenditure of a household composed of 6.1 persons in San Carlos, was ₱754.10 and of a household in Balungao, composed of 5.1 persons, was ₱493.32.

3. The 117 families covered in San Carlos includes 72.8 per cent farmers, 18.8 per cent merchants, 4.2 per cent professionals, and 4.2 per cent laborers; and the 75 families in Balungao covered by the study included 93.3 per cent farmers, 5.3 per cent professionals, and 1.3 per cent laborers.

4. In both areas studied the income of a farmer is lower than that of any of the other occupations.

5. Most of the families studied in both places own their homes.

6. The debts incurred by a family averaged ₱3.47 in San Carlos and ₱15.00 pesos in Balungao.

7. The average value of land owned by families in San Carlos is ₱1424.04 and ₱881.02 in Balungao.

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TABLE 1

Household management in San Carlos and Balungao, Pangasinan

IMMEDIATE FAMILY 117 FAMILIES IN SAN CARLOS		
		number
Husband as operator		110
Wife as housekeeper	110 homes	110
All children at home		378
Father as operator		5
Daughter as housekeeper	5 homes	5
Son as operator		2
Mother as housekeeper	2 homes	2
Total		612
IMMEDIATE FAMILY 175 FAMILIES IN BALUNGAO		
Husband as operator		74
Wife as housekeeper	74 homes	74
All children at home		228
Father as operator		0
Daughter as housekeeper	0 homes	0
Son as operator		1
Mother as housekeeper	1 home	1
Total	....	378

TABLE 2

Number of living children by families in San Carlos and Balungao, Pangasinan

110 FAMILIES IN SAN CARLOS

number of children	*number of families*	*per cent*
None	12	11.8
1	20	18.1
2	15	13.6
3	9	8.1
4	14	12.7
5	11	10.0
6	12	10.9
7	8	7.2
8	3	2.7
9	4	3.6
10	2	1.8
11 and over	0	0.0
Average number of children per family		3.6
Total[a]	110	

[a] Two homes operated by sons (single) and five homes operated by fathers, (widowers), excluded.

74 FAMILIES IN BALUNGAO

None	11	14.8
1	11	14.8
2	11	14.8
3	8	10.1
4	14	18.9
5	7	9.4
6	7	9.4
7	3	4.0
8	1	1.3
9	0	0.0
10	0	0.0
11 or over	1	1.3
Average number of children		3.1
Total[b]	74	

[b] One home operated by a son (single) not included.

TABLE 3

Size of family including all children living, domestics, and other persons permanently living with family in San Carlos and Balungao, Pangasinan

SIZE OF FAMILY 117 FAMILIES IN SAN CARLOS	Number	Average size of family
Number of family at home	598	5.8
Children at home	378	3.7
Children not at home	34	0.3
All individuals	628	6.1
75 FAMILIES IN BALUNGAO		
Number of family at home	376	5.0
Children at home	228	3.0
Children not at home	6	0.08
All individuals	384	5.1

TABLE 4

Number of children in various age groups in San Carlos and Balungao, Pangasinan

AGE GROUPS	117 FAMILIES IN SAN CARLOS	75 FAMILIES IN BALUNGAO
	number	*number*
Under 1 year	26	9
1 to 2 years	26	15
2 to 3 years	20	16
3 to 4 years	19	9
4 to 5 years	22	12
5 to 6 years	16	7
6 to 7 years	14	8
7 to 8 years	23	10
8 to 9 years	18	10
9 to 10 years	22	13
10 to 11 years	16	6
11 to 12 years	13	10
12 to 13 years	14	13
13 to 14 years	17	9
14 to 15 years	18	14
15 to 16 years	19	7
16 to 17 years	14	12
17 to 18 years	16	11
18 to 19 years	18	9
19 to 20 years	15	13
20 to 21 years	16	8
21 to 22 years, over	30	13
Total	412	234

TABLE 5

Schooling received by children in San Carlos and Balungao, Pangasinan

CHILDREN	117 FAMILIES IN SAN CARLOS		75 FAMILIES IN BALUNGAO	
	number	*per cent*	*number*	*per cent*
Under school age	138	33.5	73	31.2
Of school age	274	66.5	161	68.2
Total	412		234	
With no schooling	154	56.3	91	56.6
Received schooling	120	43.7	70	43.4
Total	274		161	
Primary grade	43	36.0	31	44.0
Intermediate grade	44	37.0	33	47.0
High school grade	30	25.0	5	6.5
College	3	2.0	1	1.4
Total	120		70	

TABLE 6

Literacy of families in San Carlos and Balungao, Pangasinan

	number	*average*	*per cent*
117 FAMILIES IN SAN CARLOS			
Read vernacular	337	2.8	28.0
Write vernacular	337	2.8	28.0
Read, write, and speak English or Spanish	263	2.2	22.0
Speak English or Spanish	263	2.2	22.0
75 FAMILIES IN BALUNGAO			
Read vernacular	177	2.3	32.8
Write vernacular	176	2.3	32.8
Read, write, and speak English or Spanish	93	1.2	17.1
Speak English or Spanish	93	1.2	17.1

TABLE 7

Data on literacy for comparison

LITERACY	P. I. CENSUS 1918	FINDINGS OF ROYECA 1922	SURVEY	
			San Carlos	Balungao
	per cent	*per cent*	*per cent*	*per cent*
Vernacular........	30.43	9.8	28.00	32.8
English...........	8.59	12.64	22.00	17.1
Spanish...........	8.53	5.25		

TABLE 8

Relation of families classified by size with various sources of family income in San Carlos and Balungao, Pangasinan

117 FAMILIES IN SAN CARLOS

Number of children	Families	Total average yearly income	Average yearly farm income	Average yearly labor income	Average yearly household income	Average yearly commercial income
	number	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*
None...............	15	1338.19	405.65	924.60	38.57	21.42
1..................	20	1249.78	243.26	777.05	123.87	110.25
2..................	16	1743.80	710.53	861.64	79.20	99.16
3..................	11	1476.84	555.20	675.40	206.25	42.00
4..................	14	1486.08	444.08	792.62	60.00	194.50
5..................	14	1760.83	472.10	117.65	82.42	112.21
6..................	12	2103.14	738.00	1049.82	81.45	208.63
7 or over..........	15	2034.67	843.30	987.04	43.63	190.40
Total..........	117	1649.16	551.51	773.20	89.42	122.32
75 FAMILIES IN BALUNGAO						
None...............	11	1158.81	312.86	775.76		
1..................	11	1333.91	539.72	612.36	18.18	9.99
2..................	11	1534.31	754.27	772.18	1.27	
3..................	8	1440.26	599.87	810.32	20.00	
4..................	15	1526.72	684.23	510.95		
5..................	7	1291.25	480.00	766.26	45.00	
6..................	7	1666.10	824.71	807.18	25.71	
7..................	5	1646.00	843.00	801.00		
Total..........	75	1449.67	629.83	732.00	13.77	1.24

TABLE 9

Comparison of size of families to the items of expenditures in San Carlos and Balungao, Pangasinan

SIZE OF FAMILY BY NUMBER OF CHILDREN 117 FAMILIES IN SAN CARLOS

	Number	Average expenses	Farm expenses	Subsistence	Clothing	Rent	Education	Care of health	Legal protection	Social life
		pesos	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*
None..	15	345.25	59.73	229.33	52.00			5.60		2.00
1.....	20	406.95	37.14	308.43	58.20	.99	17.90	1.00		5.57
2.....	16	449.89	67.74	303.00	46.32		42.63	.50		2.32
3.....	11	418.36	74.40	287.05	36.00	.36	23.60	2.60		3.50
4.....	14	511.50	54.20	340.17	31.06		82.68			9.13
5.....	14	623.80	70.70	401.07	70.78		55.91	1.56		13.46
6.....	12	810.27	126.80	474.19	99.16		105.66	3.75		13.58
7 and over..	15	898.30	105.80	572.29	106.07	8.85	114.78	4.28		12.17
Total..	117	558.04	63.31	358.55	62.51	1.12	55.39	2.41		7.50

75 FAMILIES IN BALUNGAO

	Number	Average expenses	Farm expenses	Subsistence	Clothing	Rent	Education	Care of health	Legal protection	Social life
None..	11	269.36	46.68	196.00	110.00					4.00
1.....	11	298.54	53.55	175.54	40.45		27.18			1.81
2.....	11	365.38	80.92	211.00	41.81		29.00			2.72
3.....	8	417.56	70.32	242.00	64.75	3.00	3.12			2.00
4.....	15	466.60	93.00	257.60	62.53		42.20			5.66
5.....	7	342.16	49.59	197.85	60.00		16.14			2.85
6.....	7	452.50	78.21	259.28	78.56		20.88			.70
7 and over..	5	603.73	107.78	368.55	68.00		58.40			2.00
Total.	75	401.98	61.25	238.47	65.76	.37	22.11			2.74

TABLE 10

Relation of size of family to value of land, family income and family expenditure in San Carlos and Balungao, Pangasinan

Size of family by number of children	Family	Average land value	Average yearly income	Average yearly expenditures
117 FAMILIES IN SAN CARLOS				
	number	*pesos*	*pesos*	*pesos*
None	15	638.35	1338.19	345.25
1	20	666.23	1249.78	406.95
2	16	1272.05	1743.89	449.89
3	11	909.82	1476.84	418.36
4	14	771.00	1486.93	511.50
5	14	3091.23	1760.83	623.80
6	12	2335.50	2103.67	810.27
7	15	1698.14	2034.67	898.30
Total	117	1424.04	1649.16	558.04
75 FAMILIES IN BALUNGAO				
None	11	585.33	1158.81	269.36
1	11	556.00	1333.91	298.54
2	11	680.00	1534.31	365.38
3	8	758.57	1440.26	417.56
4	15	914.00	1526.72	466.60
5	7	376.66	1291.25	342.16
6	7	2087.66	1666.10	452.50
7 and over	5	1090.00	1646.00	603.73
Total	75	881.02	1449.67	401.98

TABLE 11

Relation of size of family to value of buildings in San Carlos and Balungao, Pangasinan

SIZE OF FAMILY BY NUMBER OF CHILDREN	117 FAMILIES IN SAN CARLOS		75 FAMILIES IN BALUNGAO	
		Average value		Average value
	number	*pesos*	*number*	*pesos*
No children	15	185	11	99
1 child per family	20	242	11	104
2 children per family	16	316	11	111.50
3 children per family	11	306	8	138
4 children per family	14	270	15	161
5 children per family	14	500	7	110
6 children per family	12	412	7	246
7 children per family	8	200	3	170
8 children per family	3	350	1	160
9 children per family	4	505	1	150
All families	117	297	75	135

TABLE 12

Relation of size of family to family indebtedness in San Carlos and Balungao, Pangasinan

SIZE OF FAMILY INCLUDING ALL MEMBERS	117 FAMILIES IN SAN CARLOS		75 FAMILIES IN BALUNGAO	
		Average debt		Average debt
	number	*pesos*	*number*	*pesos*
Living alone	2			
2 members	11		8	19.70
3 members	18	1.38	11	9.70
4 members	14	2.14	11	10.00
5 members	12	.48	8	16.20
6 members	13	11.50	15	13.60
7 members	9	6.20	6	49.50
8 members	10		7	5.00
9 members and over	17	8.23	5	14.00
All families	117	3.47	75	15.00

TABLE 13

Distribution of average cost of living by income groups in San Carlos and Balungao, Pangasinan

Income groups		Average expenses	Subsistence	Clothing	Rent	Education	Care of health	Legal protection	Social life	Farm expenses
	number	*pesos*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
117 FAMILIES IN SAN CARLOS										
Below 600 pesos	1	310.00	83.8	16.1						
600 to 1100...	13	371.35	77.5	7.8	0.07	5.9	0.4			8.0
1100 to 1600...	62	434.04	67.5	11.5	0.1	6.0	0.5		.8	11.5
1600 to 2100...	18	593.60	62.9	15.2	0.6	5.9	0.0	0.02	1.2	12.0
2100 to 2600...	12	718.48	58.7	12.7		13.5	0.5		1.7	11.4
2600 to 3100...	7	997.58	58.2	12.9		12.9			.8	14.0
3100 to 3600...	2	830.75	62.2	9.0		4.9			6.6	14.8
3600 over......	2	1578.00	48.7	11.0		39.7				23.0
75 FAMILIES IN BALUNGAO										
Below 600 pesos	2	182.50	73.9	21.5					4.1	4.1
600 to 1100...	6	221.05	61.3	22.4	0.3	.6			3.6	9.6
1100 to 1600...	46	318.71	61.1	16.0		2.6			0.2	20.0
1600 to 2100...	18	566.69	54.4	14.7		11.8			0.8	17.5
2100 to 2600...	2	806.57	55.3	12.3		9.9			0.9	22.4
2600 to 3100...	1	974.44	36.8	12.0		29.2			2.0	20.4
3100 to 3600...										
3600 over......										

TABLE 14

Data from present survey and a similar study of the Philippines published by Philippine Bureau of Labor 1927

ITEMS OF EXPENSE	PRESENT SURVEY		BUREAU OF LABOR
	San Carlos	Balungao	
	per cent	*per cent*	*per cent*
Subsistence................	64.9	58.7	59.0
Clothing..................	11.9	16.5	7.0
Rent......................	.09	0.005	11.0
Education.................	8.9	9.0	5.0
Care of health............	.4		
Legal protection..........	.002		
Social life...............	1.4	1.9	
Farm expenses.............	11.7	14.9	

TABLE 15

Distribution of various items of cost of living by income groups in San Carlos and Balungao, Pangasinan

(117 FAMILIES IN SAN CARLOS)

	GROUPS OF TOTAL VALUE OF GOODS USED							
	Below 600	600 to 1100	1100 to 1600	1600 to 2100	2100 to 2600	2600 to 3100	3100 to 3600	3600 over
Number of families	1	13	62	18	12	7	2	2
Average value of all goods, pesos	310.00	371.35	434.04	593.60	718.48	997.58	830.75	1578
ITEMS	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cen*	*per cent*
Subsistence	83.8	77.5	67.5	62.9	58.7	58.2	62.2	48.7
Clothing	16.1	7.8	11.5	15.2	12.7	12.9	9.0	11.0
Rent		0.07	0.1					
Farm expenses		8.0	11.5	12.0	11.4	14.0	14.0	23.0
Education		5.9	6.0	5.9	13.5	12.9	4.9	39.7
Care of health		0.4	0.5	2.0	0.5			
Legal protection				.02				
Social life			0.8	1.2	1.7	0.8	6.6	

(75 FAMILIES IN BALUNGAO)

	Below 600	600 to 1100	1100 to 1600	1600 to 2100	2100 to 2600	2600 to 3100	3100 to 3600	3600 over
Number of families	2	6	46	18	2	1		
Average value of all goods, pesos	182.50	221.05	318.71	566.69	806.57	974.44		
ITEMS	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Subsistence	73.9	61.3	61.1	54.4	55.0	36.8		
Clothing	21.5	22.4	16.0	14.7	12.3	12.0		
Rent		0.3						
Farm expenses		9.6	20.0	17.5	22.4	20.4		
Education		0.6	2.6	11.8	9.9	29.4		
Care of health								
Legal protection								
Social life	4.1	3.6	0.2	0.8	0.9	2.0		

TABLE 16

Income and expenditures by family occupations in San Carlos and Balungao, Pangasinan

117 FAMILIES IN SAN CARLOS

OCCUPATION GROUP	FAMILIES		INCOME		EXPENDITURES		NET INCOME PER UNIT CAPITAL AND LABOR	
	number	*per cent*	*pesos*	*per cent*	*pesos*	*per cent*	*pesos*	*per cent*
Farmers	85	72.8	1654.18	25.24	551.46	25.25	0.52	21.6
Merchants	22	18.8	1650.61	25.20	550.24	25.22	0.63	26.1
Professionals	5	4.2	1622.47	24.77	540.88	24.8	0.63	26.1
Laborers	5	4.2	1622.47	24.77	540.88	24.8	0.63	26.1

75 FAMILIES IN BALUNGAO

OCCUPATION GROUP	FAMILIES		INCOME		EXPENDITURES		NET INCOME PER UNIT CAPITAL AND LABOR	
	number	*per cent*	*pesos*	*per cent*	*pesos*	*per cent*	*pesos*	*per cent*
Farmers	70	93.3	1448.91	33.9	401.83	33.7	0.82	27.9
Merchants								
Professionals	4	5.3	1440.60	33.4	399.46	33.3	1.03	35.2
Laborers	1	1.3	1412.28	32.8	391.92	33.0	1.08	36.9

A NOTE ON THE CAPACITY AND OTHER MEASUREMENTS OF THE ALIMENTARY TRACT OF AN INDIAN BUFFALO COW

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The need for accurate information regarding the capacity and length of the intestines and the capacity of the stomachs of the various mature farm animals of the Philippines has been felt for some time. As our farming system develops, and as the feeding of the animals becomes less extensive, this need is bound to be increasingly keen. In so far as this problem affects the ox, horse, sheep or goats and hog there is little need for anxiety in view of the fact that sufficient data to guide feeding work are already available elsewhere. But as far as the writers are aware no accurate data on the carabao are obtainable.

On November 25, 1929, an opportunity to make direct studies of this bovine presented itself when one of the Indian buffaloes in the College herd was mired. Having been informed of the circumstances, the Dean decided that it could be used for our studies. The animal was an old Indian buffalo cow, fairly large, measuring 132.5 centimeters (52 inches) at the withers, with a body 140.5 centimeters long[a] (55 inches), and weighing 570.4 kilograms, or 1,267 pounds, when in good health.

Some rather astonishing differences between the carabao and the ox have been discovered in regard to the capacity and length of the digestive tract. It was found that the total capacity of the four compartments of the stomach of the carabao when fully distended was 113 liters, while that of the ox is 266.9 quarts, equivalent to 256 liters. The capacity of the small intestines was found to be 28.22 liters, that of the ox is given by Henry and Morrison (1917) and by Larson and Putney (1928) at 70 quarts (66.25 liters), that of the large intestines was only 28.4 liters while that of the ox is usually given as 40 quarts (38 liters). The length of the small and large intestines was found to be 25.7 meters and 10.02 meters, respectively. Sisson (1917, p. 444-470) found these in the ox to be 130 feet (40 meters), and 30 feet (9.14 meters), respectively.

Although these differences are surprisingly great, we do not wish to be understood to say that they are significant. Such statements can be made only after a large number of cases have been studied. In reporting the data obtained from this case our object is twofold, namely, to record what was actually found, for by so doing we may stimulate active research in this very interesting field. Therefore a detailed summary of these results is given in the following table:

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[a] From the point of shoulder to pin bone.

TABLE 1

Measurements of the compound stomach and intestines of an Indian buffalo cow[e]

PARTS OF THE ALIMENTARY TRACT	CAPACITY	LINEAR OR CIRCULAR MEASUREMENT	
		cm.	*inches*
1. *Oesophagus:*			
Length from pharynx to cardiac opening		118	46
Outside circumference, fully distended		17	6.7
2. *Rumen:*			
Outside circumference at short diameter in natural condition		134	53
Gross weight of rumen with contents	55 kg. (121 lb.)		
Weight of rumen alone	12 kg. (26 lb.)		
Weight of contents alone	43 kg. (95 lb.)		
Capacity of rumen fully distended	89. l.[a] (95 quarts)		
3. *Reticulum:*			
Length from oesophageal opening to opposite end		36	14
Outside circumference, fully distended	——	71	28
Capacity, fully distended	4.87 l. (5 quarts)		
4. *Omasum:*			
Outside circumference, natural condition	——	50	20
Capacity, fully distended	4.27 l. (4.5 quarts)		
5. *Abomasum:*			
Length	——	73	29
Outside circumference at its widest part when fully distended	——	83	33
Capacity, fully distended	14.26 l. (15 quarts)		
6. *Small intestine:*			
Length	——	2570	1012[b]
Outside circumference of duodenum, fully distended	——	15.5	4
Outside circumference, fully distended	——	12	4.7
Capacity, fully distended	28.22 l. (30 quarts)		
Distance between pylorus and opening of bile duct	——	34	13
7. *Large intestine:*			
Length of large intestine, including caecum and rectum	——	1002	394[c]

TABLE 1—(Continued)

Length of caecum, natural condition. .	————	33	13
Length of caecum, fully distended . . .	————	41.5	16
Outside circumference of caecum, fully distended.	————	39	15
Distance between iliocaecal and caecocolic openings.	————	6	2.4
Capacity of caecum, fully distended. . .	3.54 l. (3.7 quarts)		
Length of large colon.	————	89	35
Outside circumference of large colon, fully distended.	————	29.5	11
Capacity of large colon, fully distended.	8.74 l. (9 quarts)		
Length of small colon.	————	997	314[d]
Outside circumference of small colon fully distended.	————	16	6
Capacity of small colon.	9.12 l. (10 quarts)		
8. *Rectum:*			
Length of rectum	————	75	30
Capacity of rectum.	5.0 l. (5.2 quarts)		
Total capacity of large intestine, including caecum and rectum.	28.4 l. (28 quarts)		
9. Total capacity of 4 compartments of the stomach.	113 l. (120 quarts)		
10. Total capacity of the small and large intestine.	157 (60 quarts)		

[a] liters.

[b] 1,102 inches = 84 feet.

[c] 394 inches = 32 feet, 10 inches.

[d] 314 inches = 26 feet, 2 inches.

[e] Name of the Indian buffalo cow was Ana, H. No. 4.

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STUDIES ON THE TREATMENT OF EQUINE SURRA IN THE PHILIPPINES, I

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Surra is one of a group of diseases known as the trypanosomiases, which also includes the so-called sleeping sickness and Chagas' disease of human beings in Africa and South America, respectively. It is prevalent in many tropical countries, and in the Philippine Islands it is responsible for the death of a large number of horses every year. The causative agent is a minute blood parasite called *Trypanosoma evansi* (Steel, 1885) and is transmitted from sick to healthy animals by horse flies (*Tabanus* species) and possibly by other blood-sucking insects.

The treatment of the trypanosomiases is still in the experimental stage in spite of the fact that during the last thirty or more years investigations in that direction have been conducted. In the present paper it is intended to describe a line of treatment for surra, which is the result of our chemotherapeutic studies on the disease during the last nine years. It is realized that the treatment has yet to be tried more extensively before its merit, if indeed it has any, can be fully established. It has been used successfully on two cases, and it was thought worth while to report it so that those who are interested might try to check it.

DRUGS USED

In these studies numerous compounds of arsenic, mercury, antimony, bismuth, and sulphur, either alone or in combinations, have been tested on experimental and natural cases of surra. We desired to try some of the newly introduced drugs, such as Bayer 205 and tryparsamide, that have been claimed to yield satisfactory results in the treatment of sleeping sickness, but we have been unable to secure them in quantities sufficient for our purpose.

The majority of the compounds tested were found to be inefficient as trypanocidal agents. The most promising results were obtained with the employment of tartar emetic (potassium antimony tartrate) in combination with mercuric iodide. For this reason, these two drugs were used exclusively in the latter part of the work. The sodium analogue of tartar emetic (sodium antimony tartrate) would probably prove to be just as good, if not better, due to its less toxicity, but it was not used because it was not available in the local market at the time these studies were in progress.

The separate and combined actions of tartar emetic and mercuric iodide

Tartar emetic has been known as an active trypanocidal drug ever since Cushny, according to Dale (1923), first suggested its trial together with other compounds of antimony and bismuth in the treatment of the trypanosomiases on account of their close chemical relationship to arsenic. When introduced into the circulation of a surra horse, it causes the trypanosomes to disappear rapidly from the peripheral blood, only to reappear several days later. It is said to possess the further disadvantage of affecting the liver, and for this reason its repeated use at short intervals may prove fatal in some cases. In the present work, it was employed without any apparent ill-effects in one-gram weekly doses, dissolved in from 30 to 40 mils of physiological salt solution and injected intravenously.

The intravenous injection of mercuric iodide has been recommended by Nainsouta (1926) and by Kelser (1928) in the treatment of epizoötic lymphangitis in the horse. In these studies, it was found that, when given alone to a horse with surra, it did not seem to exert a decided effect against the trypanosomes. When used in conjunction with tartar emetic, it appeared to enhance the trypanocidal activity of the latter. It was given every other day, three times a week, after the administration of tartar emetic, in from 0.25- to 0.30-gram doses. It was suspended in sterile distilled water, as described by Kelser, and injected into the jugular vein. In the administration of this chemical and of tartar emetic, the greatest care should be exercised not to allow any of them to get into the perivascular tissues, otherwise painful swellings, which may form abscesses, may result.

The enhanced trypanocidal effect of tartar emetic in combination with mercuric iodide was observed on two ponies (ponies No. 11 and 12) infected with surra. In both animals the use of the two drugs resulted in the disappearance of the trypanosomes from the peripheral circulation for from three to five weeks. The data of pony No. 11 are given in detail below.

Pony No. 11: gray, male, 9 years, 54 inches.

Jan. 14, 1927. Received in the clinics of the College of Veterinary Science with the complaint of irregular appetite. Blood examination positive for surra. Given tartar emetic.
Jan. 15. Blood negative. Given mercuric iodide.
Jan. 17. Blood negative. Given mercuric iodide.
Jan. 19. Blood negative. Given mercuric iodide.
Jan. 21. Blood negative. Given tartar emetic.
Jan. 23. Blood negative. Given mercuric iodide.
Jan. 25. Blood negative. Given mercuric iodide.
Jan. 27. Blood negative. Given mercuric iodide.
Jan. 28. Blood negative. Given tartar emetic.
Jan. 29 to March 3 (34 days). Animal placed under observation. Blood examined every other day with negative results.

This horse remained in good physical condition during the observation period of thirty-four days. At the end of that period it had to be returned to its owner, for our isolation ward was too crowded at the time and we had to have space for another surra case that had been brought to us. It was presumed that it had been cured, but the owner was advised to keep the animal isolated. One week afterward the owner reported that the horse had fallen down inside its stall and was unable to get up. When the animal was visited on the morning of March 12th, it was lying extended on one side. It made frequent attempts to rise, but its hind legs were too weak to support the weight of the body—this being a manifestation of surra during the last stages of the disease. The examination of the blood for the causative organism gave negative results, but the sediment of a centrifuged sample of cerebro-spinal fluid was positive. The animal died in the afternoon of that day.

With regard to the other pony (No. 12), an experimental case that was subjected to the same line of treatment, nearly similar results were obtained. During a period of observation of twenty-two days, the blood remained negative throughout. It died at the end of that period, showing typical symptoms of surra. One rat inoculated with about 4 mils of its cerebro-spinal fluid died of trypanosomiasis at the end of eleven days.

Intrathecal administration of tartar emetic

As shown in the records of these two horses, there are periods in a surra infection when the causative organism cannot be seen in the peripheral circulation, although it is invariably present in the cerebro-spinal fluid. In such cases it is not known whether the blood and the cerebro-spinal fluid are simultaneously involved, or whether the organism only gains entrance into the cerebro-spinal fluid whenever conditions in the blood become inimical to its well-being, as may happen when the host animal succeeds in fortifying itself by the formation of suitable antibodies or when trypanocidal drugs are introduced into the circulation when treatment is instituted. In any event, it is believed that when the trypanosome has established itself in the cerebro-spinal fluid, it is safe there from the toxic effects of drugs and antibodies. When conditions are again favorable, it is supposed to reenter the circulation, where it starts to multiply rapidly. According to this belief, the relapses which occur in surra may be due, at least partly, to this behavior of the causative agent.

Cognizant of the above facts and following a procedure that is sometimes practiced in the treatment of syphilis in human beings, in which there is also an involvement of the cerebro-spinal fluid, Edwards (1926) has recently advocated the intrathecal injection, in addition to the intravenous administration of trypanocidal drugs in the treatment of surra. The object is to attack the organism directly in the cerebro-spinal fluid, where, as stated above, it is beyond the reach of drugs introduced by way of the circulation. The spinal canal is punctured through the occipito-atlantal space. In our work it was decided to give this method a trial due to our failure to bring about a complete sterilization of the body by the intravenous injection of tartar emetic and mercuric iodide. Tartar emetic was chosen for intrathecal administration and the amount given was 0.002 gram, prepared and calculated in accordance with Edwards' directions. The method was tried on two experimental and two natural cases of surra (ponies No. 13, 14, 15, 16). The results were uniformly unsatisfactory. The record of pony No. 15 is given below.

Pony No. 15: bay, male, 6 years, 51 inches.

July 1, 1928. Received in the clinics of the College of Veterinary Science with the complaint of anorexia and general debility. Blood examination positive for surra. Given tartar emetic intravenously and intrathecally.
July 2. Blood negative. Given mercuric iodide.
July 4. Blood negative. Given mercuric iodide.
July 6. Blood negative. Given mercuric iodide.
July 8. Blood negative. Given tartar emetic intravenously and intrathecally.
July 10. Blood negative. Given mercuric iodide.
July 12. Blood negative. Given mercuric iodide.
July 14. Blood negative. Given mercuric iodide.
July 15. Blood negative. Given tartar emetic intravenously.
July 16 to Aug. 10 (26 days): Animal placed under observation. Blood examined every other day with negative results.
Aug. 11. Found dead in the morning.

The other ponies did not survive as long as pony No. 15. They died during the course of treatment of typical surra. In the case of pony No. 14, a few minutes before death, the blood was examined microscopically and found negative. About 10 mils of cerebro-spinal fluid, procured at the same time and injected into two white rats, failed to show the presence of trypanosomes in the blood of the latter after three months, showing that the trypanosomes, when absent in the blood, may have other places of retreat besides the cerebro-spinal fluid.

THE PROBABLE RÔLE OF BLOOD-SUCKING WORMS IN THE RELAPSES OCCURRING IN SURRA

The unsatisfactory results obtained with the intrathecal administration of tartar emetic in conjunction with the intravenous injection of the same drug and mercuric iodide, have caused us to inquire for other explanations for the relapses which occur in surra and also for the persistence of the disease in spite of the absence of the causative organism in the circulation and in the cerebro-spinal fluid. The inquiry was first directed to the blood-sucking worms that are frequently encountered in the large intestine of horses. In a trypanosomal infection, especially during periods when the protozoan organisms are numerous in the circulation, it is very probable that blood-sucking worms ingest some of the organisms together with the blood of the vertebrate host. If such a thing happens and if the trypanosomes are not destroyed or digested in the intestine of the worms, there is a possibility that the organisms may be re-introduced into the mammalian host by the same parasites during the subsequent blood-sucking activities of the latter. In other words, the hypothesis was conceived that blood-sucking worms may be capable of performng a rôle analogous to that played by certain blood-sucking arthropods in the transmission of protozoal infections. The analogy is supported by the observations of Loeb and Smith (1904), Schwartz (1921), and others, to the effect that some blood-sucking parasites, such as the various hookworms infesting the different domesticated animals, secrete poisonous substances (haemotoxins) that possess anticoagulating, haemolytic, and other properties. According to these observations, the pathological effects of the parasites on their hosts may be explained, at least partly, by the absorption of these toxic products by the host animals. Unfortunately, it is not definitely known whether haemotoxins are given off while the parasites are still alive or whether they are liberated only after the parasites die and undergo decomposition inside the intestine of their hosts. It is possible that some helminths, like many insects, inject them through wounds produced by their bites before starting to suck in order to bring about a transitory hyperaemia or in order to retard the coagulation of the blood. And it may also be possible that some blood-sucking worms, like some blood-sucking insects, possess the habit of regurgitating part of their intestinal contents before taking in fresh food. If any of these suppositions really happens, it is easy to imagine how blood-sucking parasites may be involved in the transmission of surra organisms.

In order to prove the above hypothesis, a dog (dog No. 1), which was determined by the microscopic examination of its feces to be heavily infested with hookworms (*Ancylostoma caninum*), was injected with blood from a guinea pig infected with surra. When the blood of the dog was teeming with trypanosomes, the animal was killed. Its hookworms were quickly collected after opening the entire length of the small intestine, washed several times with physiological salt solution, and then transferred into the small intestines of a healthy dog (dog No. 2) and a cat. The transplantation of the hookworms was made through canulas inserted into the small intestines after the exposure of the latter by laparotomy operations under ether anesthesia[1]. The entire procedure, from the removal of the hookworms from dog No. 1 to their transplantation to dog No. 2 and the cat, did not take more than half an hour. The cat died on the following day, probably from the effects of the operation. Dog No. 2 survived, and on the eleventh day after the operation it showed the presence of surra organisms in its blood. The infection was allowed to run its course until the animal died[2].

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[1] The writer is much indebted to Doctors San Agustin and Yutuc, under whose directions the operations were performed.

[2] This experiment has since been repeated on two other dogs, but due to some unexplained reasons the results were negative.

THE FAVORABLE EFFECT OF EXPELLING BLOOD-SUCKING WORMS IN THE TREATMENT OF SURRA

The evidence obtained from the above experiment indicates that the trypanosome of surra, after ingestion by a blood-sucking worm (*Ancylostoma caninum* of the dog), is not destroyed and that it can be reinoculated in viable state by the same worm into a susceptible animal that is suitable to the helminth as host. In view of this, the question presented itself as to the way the blood-sucking parasites of the horse, as represented by species of *Strongylus, Triodontophorus* and other nematode genera, could be a factor in the production of relapses in a surra infection and in the persistence of the disease in spite of the absence of the causative organism in the blood and cerebro-spinal fluid during treatment. By taking for granted that these equine parasites can play the same rôle as that performed by the hookworm of the dog, the question was answered by proposing the following hypothesis: When a trypanocidal agent, such as tartar emetic, is injected into the circulation of an animal with surra, the drug is capable of destroying all of the trypanosomes present in the body of the sick animal, with the exception of those that have been ingested by bloodsucking worms, if any of the latter are present. The trypanosomes in the digestive tract of these helminths are not affected by the drug, probably because the helminths themselves are sensitive to the action of the trypanocidal agent, and for this reason they refrain from sucking blood during such times when the drug is present in the circulation in sufficiently high concentrations to be harmful to them. So soon as the drug has been eliminated from the circulation, the worms may then begin to abstract blood, and by so doing they may introduce some trypanosomes present in their systems through the wounds that they produce with their bites in the intestinal wall of the mammalian host.

The above hypothesis, if it could be sustained, would also explain some of the successful cures that have been made of surra by the use of such drugs as arsenious acid, arsenophenylglycin, atoxyl, etc., by assuming that the cases treated were free from infestations with blood-sucking parasites. In order to establish the hypothesis and in order to find out if surra could be successfully treated in the absence of blood-sucking parasites, two experimental animals (ponies No. 17 and 18) were subjected to a line of treatment involving the use of an anthelmintic in conjunction with tartar emetic and mercuric iodide. The anthelmintic used was oil of chenopodium, which, according to Hall (1923), possesses nearly one hundred per cent efficacy against the strongylid parasites of the horse. The two animals were artificially infected with surra, but before starting the treatment they were allowed to develop clinical symptoms of the disease, such as, oedema of the pendant portions of the body, discoloration of, and petechial haemorrhages on, the conjunctival mucous membrane, gradual emaciation, etc. The individual records of both ponies are given below:

Pony No. 17: bay, male, 16 years, 49 inches.

March 11, 1929. Inoculated with blood from a dog brought to the clinics of the College of Veterinary Science and suffering from a natural infection of surra. The dog subsequently died as a result of the disease.
March 18. Blood positive (+).
March 21. Blood positive (++++).
March 22. Blood positive (++).
March 25. Blood negative.
March 28. Blood positive (+).
April 1. Blood positive (++++).
April 4. Blood positive (++).
April 8. Blood negative.
April 12. Blood positive (++). Given tartar emetic.
April 13. Blood negative. Given mercuric iodide.
April 15. Blood negative. Given mercuric iodide.
April 17. Blood negative. Given mercuric iodide.
April 18. Blood negative. Given tartar emetic.
April 19. Blood negative. Given mercuric iodide.
April 21. Blood negative. Given mercuric iodide.
April 23. Blood negative. Given mercuric iodide.
April 24. Blood negative. Given tartar emetic.
April 25 to May 16 (22 days): Placed under observation. Blood examined every other day with negative results.
May 17. Blood positive (+). Given tartar emetic.
May 19. Blood negative. Given mercuric iodide.
May 21. Blood negative. Given mercuric iodide.
May 23. Blood negative. Given mercuric iodide.
May 24. Blood negative. Horse weak in hind quarters. Removed about 30 cc. of cerebro-spinal fluid and then injected intravenously tartar emetic.
May 25. Blood negative. Given mercuric iodide.
May 27. Blood negative. Given mercuric iodide.
May 29. Blood negative. Given mercuric iodide.
June 1. Blood negative. Feed withheld all day. At 4 p. m. the animal was given 6 cc. oil of chenopodium in 200 cc. of linseed oil.
June 2. Feed withheld all morning. At 8 a. m. 10 cc. of oil of chenopodium in 300 cc. of linseed oil was given. At 1 p. m. the animal started to purge, expelling a large number of round worms (*Oxyuris*, *Trichonema* spp., *Strongylus* spp., and *Triodontophorus* spp.). At 3 p. m. tartar emetic was injected intravenously.
June 3. Animal still expelling worms, but feces harder. Given mercuric iodide.
June 5. Blood negative. Feces normal, but containing worms (*Trichonema* spp.). Given mercuric iodide.
June 7. Blood negative. Given mercuric iodide.
June 9. Blood negative. Given tartar emetic.
June 11. Blood negative. Given mercuric iodide.
June 13. Blood negative. Given mercuric iodide.
June 15. Blood negative. Given mercuric iodide.
June 16. Blood negative. Given tartar emetic.
June 17 to July 29 (43 days): Animal placed under observation. Blood examined every other day with negative results. On July 18, the animal developed a cold with pneumonic symptoms. Being old and much debilitated from the combined effects of disease and confinement, it was feared that it might die from the affection. It was, therefore, killed on July 30 and turned over to the Department of Anatomy to be used for class dissection.

Pony No. 18: dun, male, 4 years, 48 inches.

June 11, 1929. Inoculated with blood from a guinea pig infected with surra (dog strain).
June 18. Blood positive (+).
June 20. Blood positive (++++).
June 22. Blood positive (++).
June 25. Blood negative.
June 29. Blood positive (++).
July 1. Blood positive (++++).
July 3. Blood positive (++). Given tartar emetic.
July 4. Blood negative. Given mercuric iodide.
July 6. Blood negative. Given mercuric iodide.
July 8. Blood negative. Given mercuric iodide.
July 9. Blood negative. Given tartar emetic.
July 10. Blood negative. Given mercuric iodide.
July 12. Blood negative. Given mercuric iodide.
July 14. Blood negative. Given mercuric iodide.
July 15. Blood negative. Given tartar emetic.
July 17. Blood negative. Given mercuric iodide.
July 19. Blood negative. Given mercuric iodide.
July 21. Blood negative. Given mercuric iodide.
July 22 to Aug. 14 (24 days): Animal placed under observation. Blood examined every other day with negative results.
Aug. 15. Blood positive (+).
Aug. 16. Blood positive (++). Given tartar emetic.
Aug. 17. Blood negative. Given mercuric iodide.
Aug. 19. Blood negative. Given mercuric iodide.
Aug. 21. Blood negative. Given mercuric iodide.
Aug. 23. Blood negative. Animal showing symptoms of paralysis in hind legs. Removed about 30 cc. of cerebro-spinal fluid and then injected tartar emetic intravenously.
Aug. 24. Blood negative. Given mercuric iodide.
Aug. 26. Blood negative. Given mercuric iodide.
Aug. 28. Blood negative. Given mercuric iodide.
Aug. 30. Blood negative. Afternoon feed withheld. At 4 p. m. 6 cc. of oil of chenopodium in 200 cc. of linseed oil was given.
Aug. 31. Feed withheld all day. At 7 a. m. 10 cc. of oil of chenopodum in 300 cc. of linseed oil was given. At 11 a. m. the animal started to purge, passing a large number of worms (*Oxyuris*, *Trichonema* spp., *Strongylus* spp., and *Triodontophorus* spp.). Given tartar emetic at 4 p. m.
Sept. 1. Animal still purging and eliminating worms. Appeared very weak. injected ¼ grain strychnine sulphate subcutaneously.
Sept. 2. Animal still purging and eliminating worms. Much depressed; anorexia. Drenched with a mixture of tannic acid and salicylic acid mixed with starch gruel and sugar in order to stop purgation and to furnish nourishment.
Sept. 3, 4. Feces becoming gradually harder; few worms (*Trichonema* spp.) present. Off feed; starch gruel, and sugar continued.
Sept. 5. Blood negative. Appetite returning, but animal very weak; prefers to lie down. Removed about 25 cc. of cerebro-spinal fluid and then injected intravenously tartar emetic and ¼ grain strychnine sulphate.
Sept. 6. Blood negative. Given mercuric iodide.
Sept. 8. Blood negative. Given mercuric iodide.
Sept. 10. Blood negative. Given mercuric iodide.

Sept. 12. Blood negative. Given tartar emetic.
Sept. 13. Blood negative. Given mercuric iodide.
Sept. 15. Blood negative. Given mercuric iodide.
Sept. 17. Blood negative. Given mercuric iodide.
Sept. 18. Blood negative. Given tartar emetic.
Sept. 19, 1929, to Jan. 14, 1930 (118 days): Animal placed under observation. Blood examined every other day or twice a week with negative results.

It will be noticed from the above records that in the beginning of treatment only tartar emetic and mercuric iodide were employed. As a result, both animals suffered from relapses of the infection at the end of from twenty-two days (pony No. 17) to twenty-four days (pony No. 18) after they received their last injections. When the same drugs were used after ridding the animals of their blood-sucking worms with oil of chenopodium, no further relapses occurred. These facts are mentioned in order to bring out the point that, in the absence of separate control animals, each case was utilized in the double rôle of a control and an experimental animal in the attempt to show the favorable effect of expelling blood-sucking worms in the treatment of surra.

It is unfortunate, due to the circumstances mentioned above, that pony No. 17 was kept under observation for only forty-three days. Because of this, one is not fully justified in pronouncing the result of the treatment as very conclusive. Considering, however, the time during which the horse remained negative, as determined by the microscopic examination of the blood, which is longer than we have yet been able to bring about by the exclusive use of trypanocidal drugs; and the fact that the animal failed to infect white rats that were inoculated with samples of its blood and cerebro-spinal fluid procured immediately before it was killed—these would lead to the assumption that the treatment has been efficacious.

In the case of pony No. 18, the successful result of the treatment is beyond question. This horse had become so weak and emaciated, due no doubt to the effects of surra, that it was not expected to live. As a matter of fact, in the morning of September 5, 1929, when it was found lying on the ground with no desire to get up, the caretaker of the animal, who has seen the majority of our cases during the last stage of the disease, thought that the fatal termination was a question of only a few hours and had, therefore, started to dig a hole in the ground in anticipation of another interment. Due to the treatment, it has gradually gained in flesh and strength and at the time of writing, January 14, 1930, or one hundred and eighteen days since the last injection was given, it appears normal in every possible way. In fact, it is now in much better physical condition than before it was infected with surra. In order to be absolutely sure, however, that the animal has been permanently cured, about 15 cc. of its blood and 10 cc. of cerebro-spinal fluid were injected on December 6th into four white rats. On the same date and on December 16th, samples of the animal's serum were forwarded to the Bureau of Science in Manila for the application of the complement fixation test for surra. Up to the time of writing, or thirty-nine days after the inoculation was made, the white rats have failed to show the presence of trypanosomes. Captain F. H. K. Reynolds of the United States Army Medical Department Research Board, who performed the complement fixation test and whose assistance is, therefore, very gratefully acknowledged, advised that the results of the test were negative.

It thus appears, as evidenced by the satisfactory results obtained, that the expulsion of blood-sucking parasites by the use of an appropriate anthelmintic exerts a favorable influence in the treatment of surra with tartar emetic and mercuric iodide. There are, however, two other factors which should be considered and which, it is believed, contributed to the success of the treatment. These are: (1) the withdrawal of small amounts of cerebro-spinal fluid by penetrating into the spinal canal through the occipito-atlantal space, and (2) the provision of adequate nourishment and exercise for the animal during the course of the treatment.

The removal of small amounts of cerebro-spinal fluid, especially immediately before or after the introduction of tartar emetic into the circulation, may have been beneficial in one of two ways or both. In the first place, the pressure within the spinal canal may have been reduced. If our suspicion that the paralytic symptoms in the hind quarters during the later stages of equine surra are due to an increased intraspinal pressure, then the letting out of some cerebro-spinal fluid may have prevented or, at least, retarded the appearance of these symptoms. In the second place, as shown by Flexner and Amoss, according to Kolmer (1920), the penetration of the meninges may have produced an aseptic meningitis, which increased the permeability of the choroid plexus and meninges and by so doing promoted the diffusion of the trypanocidal agent into the cerebro-spinal fluid.

During treatment, an animal should receive some form of light exercise and should be supplied with a liberal amount of nourishing food. In the beginning all of our cases were constantly kept confined inside a screened isolation room as a precaution against the spread of the disease. As to be expected, even normal animals that are accustomed to an outdoor existence, if kept thus enclosed for any length of time, will not feed well and will not do well due to their inability to roam about for exercise. In order, therefore, to give it better chances of making a rapid recovery, beginning on October 2, 1929, or two weeks after receiving its last injection, pony No. 18 was allowed to graze every morning in an open field, where it was tied with a long rope, far removed from other animals. It is undoubtedly due to this that the animal has been able to put on flesh rapidly. It is believed that the practice is quite safe in so far as the spread of the disease is concerned, provided that the blood is determined to be negative by microscopic examination every other day or twice a week and provided further that the case being treated is kept far from other animals.

SUMMARY AND CONCLUSIONS

1. The disease called surra is prevalent in many places in the Philippine Islands and is responsible for the death of a large number of horses every year. Attempts to raise these animals on a large scale and to improve the breed of the undersized Filipino pony have invariably failed, due to its ravages.

2. In view of its importance, chemotherapeutic studies have been undertaken by the writer for the purpose of finding an efficacious and a practical method of curing the disease.

3. As a result of the studies, a line of treatment, which seems promising in view of its having been used successfully in two cases, has been developed. It consists in the intravenous injection of trypanocidal drugs (tartar emetic and mercuric iodide) and in the oral administration of an anthelmintic (oil of chenopodium) for expelling whatever blood-sucking worms may be harbored by the animal affected with surra.

4. Experimental evidence has been obtained to show that blood-sucking worms ingest the trypanosome of surra together with the blood in which the organism is found, and that the same helminths are capable of inoculating it in viable state back to the mammalian host during the process of sucking blood.

5. The relapses in surra and the persistence of the disease in spite of the absence of the causative organism in the circulation and in the cerebro-spinal fluid are probably due in part, at least, to the rôle played by blood-sucking worms as discussed above (4). The expulsion of these parasites by means of an anthelmintic,as an adjuvant to the use of trypanocidal drugs, as stated in (3), is, therefore, indicated.

6. During treatment the occasional removal of small amounts of cerebro-spinal fluid, specially immediately before or after the administration of trypanocidal agents, appears to be beneficial. The practice is of aid in the maintenance of a normal intraspinal pressure, thus preventing or retarding the appearance of paralytic symptoms in the hind limbs. It also induces an aseptic meningitis, thereby increasing the permeability of the choroid plexus and the meninges and thus promoting the diffusion of trypanocidal drugs into the cerebro-spinal fluid.

7. During treatment, animals should be allowed some form of light exercise and a liberal amount of nourishing food.

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A STUDY OF THE MARKETING OF COPRA IN LUCENA, TAYABAS

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Coconut products constitute one of the major exports of the Philippine Islands, the value of which, in 1928, was ₱97,835,301. Out of this amount, ₱45,084,682 was from copra, ₱46,973,345 from oil, and the rest, ₱5,772,274, from copra meal. On the basis of value, coconut products rank third among Philippine agricultural production and first among Philippine exports. Table 1 shows the relative importance of Philippine agricultural products and exports, on the basis of value.

The fact that copra is one of our major agricultural products is good reason to justify any serious attention paid to the study of the methods of marketing this commodity. No comprehensive work has yet been published on the study of the marketing of copra in the Philippine Islands, or in any part of the country. Arnaldo, in his unpublished thesis for graduation from the College of Agriculture, University of the Philippines, in 1927, mentioned copra as one of the leading products of the province of Laguna which passes through the hands of two or more middlemen in its movement from the farmer to the consumer. He did not, however, make a detailed study of the methods of marketing copra alone.

This study was conducted in Lucena, Tayabas, one of the most important shipping centers for this product in the coconut region in Luzon. The purposes of the study were to gather first-hand information about the marketing of this commodity for students in rural economics, to gain an idea of the degree of accuracy of the information gathered by thesis students doing work on marketing of different agricultural products in their respective towns and provinces, and to find the weaknesses, if any, in the methods of marketing copra with a view to suggesting improvements.

The investigation was made during the periods from December 26-31, 1928, and October 15-22, 1929.

METHOD OF SURVEY

The inquiry method was used, that is, merchants, producers, transportation men, government officials, bank officials, and some employees of companies were asked various questions regarding the buying and selling of copra.

MARKETING

Methods of preparing copra for market

There are two general ways of preparing copra for market, in so far as expense in preparation is concerned. These are: (1) by contract labor, and (2) by the share (tenancy) system.

Contract labor. There are two forms of contracts entered into between the laborer and the plantation owner. In the most common form the plantation owner pays ₱5.00 per 1,000 nuts gathered and assembled at the *tapahan*, husked, split open, turned into copra, and placed in sacks ready for market by the laborer. The contract terminates when the laborer has placed the finished copra in sacks and has piled them at the *tapahan.* The plantation owner takes care of selling the product to the commission merchants at the railroad station.

Under this contract it takes an average of ten days to finish the work of preparing 1,000 nuts for sale. The length of time, of course, depends upon weather conditions. During sunny days, it takes a much shorter time than when it is raining.

The second form of contract is that in which the plantation owner pays ₱2.50 to ₱3.00 per 1,000 nuts already assembled at the *tapahan.* The laborer will husk the nuts, split them, make copra and place this in sacks. It takes an average of six days to finish this work.

Under the two forms of contract labor, the laborer feeds himself. He is given the use of the *tapahan* or drying chamber. He spends nothing in making the copra because he utilizes the husks and the shells for fuel.

This method of preparing copra for market is common among the small farmers, and those proprietors whose plantations are near the town.

The share (tenancy) system. The tenancy share system is practiced in two forms in Lucena among coconut plantation owners. There is the two thirds-one third basis and the three fourths-one fourth form. The two thirds-one third method is the most commonly practiced among large plantation owners. The three fourths-one fourth system is rarely used, except in places where conditions are especially favorable, such as exceptional productiveness of the plantation, proximity to town, and good roads.

Under the two systems of share tenancy, the plantation owner does not interfere with the preparation of the copra for market. His only concern is to know the number of nuts secured at each harvest. He gives the entire care of the plantation to his tenants who take the copra to the railroad station where it is sold by the owner to the buyers. Often he has already paid for the share of his tenants in advance. If the tenants have not taken their share, they receive one third or one fourth of the selling price of the copra, depending on their contract.

The owner usually buys the shares of his tenants in advance. He contracts for their share at a certain price, or lends them money whenever they are in need and collects from them copra to repay the loan. Generally, he gets a picul of copra for every ₱5.00 loaned long before harvest. Thrifty tenants, however, do not sell their copra in advance. They wait until the whole product is sold and then get their share in cash.

The tenants who sell their product in advance receive very low prices for their copra. Moreover, they usually become deeply indebted to their landlord so that they cannot leave the plantation if they so desire. The tenants who do not sell their crop in advance receive the same price for their copra as their landlord. They are free to leave the plantation at any time. They are privileged to sell their share to whomever they choose.

Means of transportation

The ease and rapidity with which a product is distributed depends largely upon the transportation facilities. In Lucena copra is transported on carabaos from the distant plantations to the provincial road. Once assembled by the road, it is transported to the railroad station in trucks or *calesas*. The product is sold immediately to the commission merchants representing the Manila exporters. These merchants have a row of *bodegas* along the railroad tracks at the Lucena station. The copra they buy is weighed and prepared for shipment at the *bodegas*.

Terms of sale

As far as terms of sale are concerned, in Lucena copra is sold in two ways, namely, for cash, and by contract before harvest. The large proprietors and those copra producers who employ contract labor in preparing their product for market sell their copra for cash. They deliver their copra to the commission merchants at the station and are paid in cash for the amount delivered. A large number of plantation owners contract the copra shares of their tenants long before harvest time. They generally do this by lending money to these tenants with the agreement that such loans be paid back in copra.

Methods of sales

This study of the marketing of copra includes only the movement of the commodity from the coconut plantations to its delivery to the commission merchants at the Lucena railroad station for shipment to the Manila exporters. It does not involve a study of the movement of the product after that.

Direct sales without the aid of middlemen. There is no direct dealing between the Manila exporters and the copra producers in Lucena. This fact may be due to the lack of sufficient produce, even among the individual large proprietors, to warrant the hiring of freight trains by the producers. Moreover, the copra producers are not organized into any form of association which might enable them to combine their produce under one management and ship it by freight direct to the exporters in Manila. The Manila Railroad Company does not ship commodities by freight when there are only three or four carloads of the product, on account of expense. During September, 1929, the average daily shipment of copra from Lucena amounted to 59,835.4 kilograms or nearly sixty tons. This required an average of seven cars with a load of about 9,000 kilograms of copra each. No individual coconut planter in Lucena produces sufficient copra to enable him to engage a freight train carrying a daily load of about sixty tons. The shipping, therefore, is performed by the commission merchants who buy copra from different farmers and are thus enabled to assemble enough for economical shipment. Even the commission merchants have to get together to engage a freight train to carry their purchases to Manila. During September, 1929, there was an average of five commission merchants representing five different exporters in Manila.

Transfer through one middleman. A conservative estimate of the amount of copra sold through single middlemen is about 70 to 80 per cent of the total copra production of the town.

The following companies are represented by commission merchants at Lucena. Each of them has a *bodega* where the copra is held awaiting shipment to Manila.

Compañía General de Tabacos de Filipinas.
Philippine Refining Company.
Manila Export Corporation.
Luzon Industrial Corporation.
Jao Cui Pien and Company.
Bio Chuan and Company.

Marketing through two middlemen. There are some persons who buy copra with their own capital and sell it to the commission merchants. These private buyers establish small country stores along the provincial road at certain places which are suitable for assembling their purchases for economical transfer to the railroad station. About 20 to 25 per cent of the copra in Lucena is marketed by this method.

Two things are essential in order that these country dealers can buy enough copra to give remuneration for their effort, namely, they should have enough cash on hand; and they must be acquainted with a large number of the small producers and tenants who often come to borrow small sums of money, promising to pay such loans in copra. Their wide acquaintance with the small producers and tenants insures for them a fair volume of business.

These private buyers in Lucena are all Filipinos. Some of them have coconut plantations of their own, but the produce of their own farms does not yield enough to supply their needs, hence their activity in buying and selling copra.

Transactions involving three or more middlemen. There are rare instances where the commission merchants at the railroad station employ agents to buy copra at the remote barrios with the promise to give such buyers a part of their commissions. These are the only cases where three middlemen are involved in the marketing of copra from the farmer to the exporter through the commission merchant. The amount of copra sold by this method, however, is relatively small.

Co-operative marketing. There is no co-operation among the copra producers in Lucena. Each farmer is free to exercise his own will in the production and sale of his product. This results in a keen competition among themselves, which weakens their position when it comes to fixing the price for their copra. The organization of a co-operative marketing association among the copra producers of that town would greatly improve the methods of marketing, with the result that they would receive very much better prices than they now get. Co-operation would eliminate competition among the producers. Co-operation would also bring about improvement in the quality of copra produced as it would enable the producers to place a premium on quality rather than on quantity as is often the case among producers who compete among themselves.

The fixing of prices

There is only one basic price for all kinds of copra in Lucena, which is quoted by the commission merchants at the railroad station, and upon which bargaining is based. A careful examination of the price of copra on the daily market reports of the Bureau of Commerce and Industry reveals that the quoted price at the Lucena railroad station is based upon the price of the *corriente mejorado* copra. The commission merchants admit that this price is the basis of their quotations at the station. The opening price of copra in Lucena on October 17, 1929, was ₱8.75 a picul. The price of a picul of this commodity at Manila, according to the market reports of the Bureau of Commerce and Industry, were:

Corriente	₱8.125	to	₱8.25
Corriente mejorado	8.625	to	8.75
Buen corriente	9.125	to	9.25
Semi resecada	9.625	to	9.75
Resecada	10.125	to	10.25

These prices were still prevailing on October 22, after this investigation was finished.

On October 18, the quoted price of the previous day increased to ₱8.85, or an increase of ten centavos a picul. This was due to the sudden demand for copra to fill the cars before the freight train could start. Besides, there was a steamer leaving Manila, and the copra was needed in Manila for shipment abroad. The fluctuation in price at Lucena is not great, and it occurs only when there is a boat at Manila which loads copra for the United States. The increase in price, too, is not great. It does not go beyond twenty centavos a picul at normal times, yet there are rare instances when the increase is over one peso a picul.

The price quoted at the railroad station is not generally that received by the farmers, unless they themselves haul and sell their copra there. To illustrate: on October 17, the quoted price was ₱8.75 a picul. A country dealer buys copra at a barrio two kilometers away from the town. This country buyer knows that the price of copra at the station is ₱8.75. He knows too that it costs him 20 centavos to haul a picul of copra from that barrio to the station. Moreover, he buys copra with the desire to receive something in return for his efforts. Naturally, he offers a price to the farmer very much lower than ₱8.55, the quoted price minus 20 centavos, the cost of hauling a picul of copra to the station. He might succeed in buying at only ₱7.00 a picul, or at least very much less than the quotation in order that he may be able to sell at a profit. The further from the town the farmer is, the lower the price he will receive for his product, because of the increased cost of hauling to the station.

When the producers sell their copra by contract before harvest, they do not get the benefit of prevailing quotations, as they usually agree to deliver to their creditors a picul of copra for every ₱5.00 borrowed, a figure that is considerably lower than the current price.

Marketing costs

The cost of marketing in Lucena, as discussed below does not include all the expense of moving the copra from the farmer to the final consumer. It includes only those items involved in the moving of this product from the farm to the railroad station.

Cost of harvesting and assembling nuts. The nuts are scattered under the trees when they are dropped by the gatherer. These nuts are assembled and hauled to the *tapahan* in a sledge pulled by a carabao. It costs ₱1.00 to harvest and haul 1,000 nuts to the *tapahan.* This charge is approximately 25 centavos a picul of copra. If the owner of the plantation owns the sledge and the carabao, this amount is included with the ₱5.00 per 1,000 nuts paid for copra making.

Tenants who work on the share basis take care of the expense of preparing the copra for market.

Cost of hauling copra to the provincial road. The owner pays from 30 to 40 centavos a picul for having his copra carried on carabaos from the plantation to the provincial road. The charge is 30 centavos a kilometer during dry season and 40 centavos a kilometer during the wet season, when the way is muddy.

Cost of hauling copra from the road to the railroad station. From the provincial road the copra is hauled to the railroad station in trucks or in *calesas.* The minimum charge is 20 centavos a picul within four kilometers of the town; beyond this the charge increases in proportion to the distance, the charge being two centavos a picul for every additional kilometer.

Cost of weighing and loading. When the copra is received at the *bodega* of the commission merchant, it is weighed and stored until it is loaded in freight cars. It costs three centavos a picul to weigh the copra and three centavos to load it on the freight cars.

Internal Revenue charges. The copra buyer pays three centavos as internal revenue charge for every picul bought.

Summary of marketing costs. The cost of marketing copra in Lucena, is divided into two parts in order that the explanations may be clear. There is that part which is borne by the farmer and the other part which is borne by the buyer. The marketing costs are summarized thus:

Part borne by the farmer:

Items	*Each picul in pesos*
Cost of hauling copra to road	₱0.30 to ₱0.40
Cost of hauling copra from road to railroad station	0.20 to 0.50
Cost of weighing at the station	0.03 to 0.03
Total	₱0.53 to ₱0.93

Part borne by the buyers:

Items	*Each picul in pesos*
Cost of loading in freight cars	₱0.03 to ₱0.03
Cost of Internal Revenue charges	0.03 to 0.03
Freight from Lucena to Manila	0.35 to 0.38
Total	₱0.41 to ₱0.44

Summary: Under the present method, shipping by railroad, the expenses are as follows:

Part borne by the farmer	₱0.53 to ₱0.93
Part borne by the buyer	0.41 to 0.44
Total	₱0.94 to ₱1.37

From the foregoing costs of marketing, it is seen that the farmer spends, under the present method of shipping copra by train from Lucena to Manila, from ₱0.53 to ₱0.93 per picul. This means that he will receive only from ₱7.82 to ₱8.22 a picul if his copra sells at ₱8.75 a picul at the railroad station. If the cost of producing copra is deducted from this amount, which will be discussed later, then the net profit of the farmer may be determined.

Financing marketing operations

Private financing. The large majority of the copra producers in Lucena furnish their own capital for the production of copra. They always put aside some money for their expenses in producing copra after they have received the proceeds from their present production. Because these copra producers are not fond of borrowing money for crop production, the Philippine National Bank in Lucena does not have any funds to carry crop loans as that branch of the same bank in Negros Occidental does, where the crop loans amount to over ₱4,000,000 a year.

Bank loans. The only bank in Lucena is a branch of the Philippine National Bank. This bank lends money to merchants and dealers in copra. According to the bank, there are from ₱30,000 to ₱50,000 laid aside for loans to these business men. The largest individual loan is ₱18,000. All the loans are secured by real estate and are of 90 days to one year duration.

The loans that the coconut plantation owners get from this bank are not used for producing copra. They borrow money for permanent improvements or for the purchase of real estate. Most of their loans are long-term, running 5 years and more. They are mortgages, not crop loans. The bank charges 10 per cent interest on loans.

AMOUNT OF COPRA SHIPPED FROM LUCENA

The importance of Lucena as a shipping center for copra is seen from the fact that about 90 to 95 per cent of the total tonnage of freight from the Lucena railroad station is copra. Figures obtained from the railroad station representing shipments for two months and seventeen days show that the average daily shipment of copra from Lucena amounts to 71,745.5 kilograms, or 1,147.93 piculs. This is equivalent to ₱10,044.39 if a picul is quoted at ₱8.75. Table 2 shows the volume of copra shipped by railroad from Lucena to Manila.

COST OF PRODUCTION OF COPRA IN LUCENA

A knowledge of the cost of producing copra in connection with the study of methods of marketing this product is in order to enable one to determine whether the farmer is making any profit or not. The cost of production plus the cost of marketing borne by the farmer gives the aggregate cost price of the commodity in question. This cost price subtracted from the selling price gives the net profit.

An effort is made to estimate as closely as possible the cost of producing copra from 1000 nuts supposed to be harvested from 100 trees planted on half a hectare of land. There are four harvests a year, that is, nuts are gathered from these 100 trees once every three months. The 1000 nuts are supposed to yield four piculs of copra. The land is supposed to be second class with an assessed value of ₱105 a hectare; the trees are also supposed to be second class with an assessed value of ₱4.50 a tree. The market value of the trees is supposed to be ₱5.00 each. Depreciation on implements, buildings, equipment, etc., is supposed to be 10 per cent.

Table 3 shows that the cost of producing a picul of copra is ₱5.86. The total cost of marketing that is borne by the farmer is from ₱0.53 to ₱0.93 a picul. It is, therefore, seen that the total cost price of a picul of copra (₱5.86 + ₱0.53 or ₱5.86 + ₱0.93) is from ₱6.39 to ₱6.79.

It is obvious from the foregoing figures that those copra producers in Lucena who sold their produce at ₱8.75 a picul made profits ranging from ₱1.96 to ₱2.36. Those who sold at ₱8.85 a picul made profits ranging from ₱2.06 to ₱2.46.

It should be borne in mind, however, that the above estimates are not very accurate.

SUMMARY

Certain points should be emphasized regarding the marketing of copra, based upon the present study of marketing this commodity in Lucena. These are:

1. Copra passes through the hands of one to three middlemen in its movement from the farmer to the Manila exporter. This unnecessarily increases the cost of marketing, thereby unnecessarily reducing the price received by the farmer because the middleman has to buy at a price which insures for him a margin of profit. The fusion of the services of unnecessary middlemen into one management, such as the case in a co-operative organization, would reduce the cost of marketing to the minimum and increase the price received by the farmer.

2. The presence of commission merchants to assemble copra for economical shipment to the Manila exporters is necessary under the present system of marketing this product. The individual farmers cannot produce sufficient copra to enable them to ship their produce economically by freight train. The average daily shipment of copra from the Lucena railroad station, based upon two and one half months records, amounts to 71,745.5 kilograms, or 1,147.93 piculs. No individual farmer in the locality can produce that much copra daily.

3. It costs the farmer from 53 to 93 centavos a picul to sell copra at the Lucena railroad station to the commission merchants representing the Manila exporters. Such expense could be very much reduced by the improvement of roads and the use of transportation facilities with greater speed than the carabao.

4. The copra producers need a co-operative marketing association. There is enough copra in Lucena to warrant the establishment of such an organization which would help the farmers to secure economy in marketing and a better price for their crop. Through a co-operative marketing association, the copra producers could market their produce directly to the Manila exporters, thereby saving the amount which the commission merchants secure in doing this service for them.

5. The price for copra in Lucena, although fixed by the commission merchants at the railroad station, seems to be fair enough as these commission merchants cannot offer a price which is very far below the quotations in Manila on account of the proximity of the place to the city and the fact that many of the large plantation owners get daily information through the mails from Manila. As a matter of fact, the copra producers get a better share of the quoted price for their product than do the tobacco farmers in the Cagayan Valley. The copra producer may be able to get as much as 90 per cent of the quoted price, if he sells his product through only one mid-

dleman, whereas the tobacco planter in the Cagayan Valley usually receives only from 20 to 60 per cent of the quoted price.

6. The copra producers of Lucena finance their marketing operations from their own savings. They seldom borrow from banks for the purpose of marketing their crop.

7. A conservative estimate, based on 1,000 nuts, places the cost of production of copra at ₱5.86 a picul. Added to this the farmer's cost of marketing, it becomes from ₱6.39 to ₱6.79 a picul. At the rate of ₱8.75 a picul, the farmer can still make a profit of from ₱1.96 to ₱2.36. That price was the lowest quotation at Lucena during the investigation. The cost of production could be further lowered through improvements in the method of making copra. All the coconut producers interviewed used the *tapahan* method. The production of copra by this method is very slow and therefore expensive.

TABLE 1

Relative importance of Philippine agricultural production and exports, on the basis of values 1928[a]

CROP	VALUE OF PRODUCTION	VALUE OF EXPORTS
	pesos	*pesos*
Rice	183,293,130	None
Sugar	114,136,710	95,085,879
Coconut products	85,408,430	97,835,301
Abaca	54,362,440	53,187,212
Corn	26,047,100	None
Tobacco	9,334,770	17,142,873
Maguey	3,288,130	3,524,648
Cacao	1,183,700	1,896
Coffee	868,600	None

[a] The data given here are from Statistical Bulletin No. 11, 1928, of the Bureau of Commerce and Industry.

TABLE 2

Quantity of copra shipped by railroad from Lucena to Manila

DATE	NOVEMBER, 1928		SEPTEMBER, 1929		OCTOBER, 1929	
	Weight in	Freight	Weight in	Freight	Weight in	Freight
	kg	*pesos*	*kg*	*pesos*	*kg.*	*pesos*
1	80,761	493.92	58,404	357.47	88,391	540.94
2	96,614	591.12	34,132	208.93	96,731	586.33
3	74,042	452.61	32,131	184.39	77,225	472.58
4	91,573	560.06	52,203	320.01	99,830	610.95
5	107,641	660.63	75,233	460.87	107,533	652.69
6	109,954	673.00	23,091	141.10	79,312	485.20
7	59,789	310.30	57,356	350.41	108,889	673.51
8	95,403	592.30	50,369	308.05	99,533	609.55
9	94,227	606.83	52,108	318.55	63,320	387.57
10	72,851	445.89	43,275	264.35	90,411	552.49
11	89,560	547.78	61,286	375.21	88,671	541.80
12	43,261	264.40	34,333	209.89	131,516	804.13
13	39,470	241.49	63,509	388.34	95,588	585.02
14	15,153	98.08	93,311	570.42	63,406	387.27
15	36,154	208.08	81,120	496.51	106,471	651.38
16	23,105	141.22	81,339	497.03	69,751	426.58
17	41,897	256.22	66,246	414.30	63,383	387.99
18	45,937	281.22	43,404	265.54		
19	41,764	255.49	18,000	110.16		
20	34,508	211.00	92,514	565.68		
21	53,416	327.23	53,390	430.51		
22	67,761	421.46	52,114	318.16		
23	62,012	322.70	68,385	418.20		
24	18,202	111.05	75,457	467.32		
25	54,659	333.91	34,094	208.68		
26	18,271	111.54	92,441	569.64		
27	153,958	945.22	79,283	484.23		
28	69,688	429.58	81,539	498.91		
29	89,320	544.88	47,179	350.00		
30	80,158	490.01	97,816	598.64		
Total	1,962,109	11,929.22	1,795,062	11,151.50	1,529,961	9,355.98
Ave. Daily	65,403.6	397.64	59,835.4	371.71	89,997.7	550.55
Freight each kg......		0.006		0.0056		0.0061
Freight each picul[b].		0.375		0.35		0.38

[b] One picul is equivalent to 62.5 kilograms.

TABLE 3

Cost of producing copra on the basis of 1000 nuts

ITEMS OF COST	COST
	pesos
Average cost of making copra	4.00
Tax on one-half hectare of land assessed as second class at ₱105.00 a hectare, and rate of taxation being 87½ centavos for every ₱100.00	0.115[d]
Tax on 100 trees assessed as second class with assessed value of ₱4.50 a tree and computed on the basis of 4 harvests a year	0.985
Interest on capital invested on 100 trees at ₱5.00 a tree, interest being 6 per cent and computed on basis of 4 harvests a year	7.50
Upkeep of 100 trees at 10 centavos a tree per year, computed on basis of 4 harvests a year	2.50
Depreciation on value of implements, equipment, farm house, tools, etc., at 10 per cent per annum, computed on basis of 4 harvests a year	8.35
Total	23.45
Cost of producing each picul	5.86[c]

[c] It is supposed that 1000 nuts yield 4 piculs of copra.

[d] Tax on land is computed as one-fourth of the total tax, there being 4 harvests in year, or 4000 nuts yielded by the half hectare.

COLLEGE AND ALUMNI NOTES

Professor Dutcher, of Wesleyan University, was convocation speaker at the College of Agriculture on February 19.

Mr. Florentino F. Cruz, '16, who is one of the three graduates of this College who hold the honorary degree of Master Farmer, granted in 1923 on account of signal accomplishment as a farmer, delivered an interesting talk on February 4 before the faculty and student body on cattle raising and management in Mindanao. Mr. Cruz is manager of the Nellore Ranch at Lomgan, Bukidnon, and is likewise owner of another which contains approximately 1,000 head of cattle. The experiences of Mr. Cruz are of special interest because he began with almost nothing in a place in which he was a total stranger. Moreover, because he has had since boyhood a terror of riding horseback, he trained his cattle to be managed by a horseless rancher. To a student who asked him what he considered the most important disease of cattle in Mindanao, his quick reply was, "negligence!"

The College of Agriculture has a large graduating class of sixty-two members for the present academic year.

At the annual stockholders' meeting of the College Co-operative Co., Inc., on February 5, a rebate of 5½ per cent was declared on purchases, a dividend of 16 per cent on preferred stock, and 6⅔ per cent on common stock. The business transacted during 1929 amounted to ₱60,353.43. The following officers were elected: president, Dr. F. O. Santos; vice-president, Dr. L. B. Uichanco; secretary-treasurer, Dr. A. L. Teodoro; manager, Dr. F. T. Adriano (reelected unanimously); members of the board of directors, Dr. Miguel Manresa, Dr. R. B. Espino, and Prof. M. A. Roa; committee on revision of the by-laws, Dean B. M. Gonzalez, Dean G. San Agustin, and Doctor Uichanco.

The members of the Maquiling Ladies' Club were guests at the Animal Husbandry Seminar on February 10, when curing of ham and bacon and making sausages was demonstrated by two thesis students. Liberal samples were presented to the visitors, showing that the department was prepared to subject its products to that severest of tests—the judgment of the housewife.

The following papers were read at the fifty-first scientific meeting of the Los Baños Biological Club on February 27:

1. Mr. A. B. Catambay. Efficiency of different plows.
2. Dr. A. C. Gonzaga. Normal temperature and pulse and respiration ratio of Philippine ponies.
3. Dr. F. O. Santos and Mr. E. G. Collado. The nutritive value of Philippine cereals: II. *Gariñgan tapucoy.* Paper read by Mr. Collado.

Members of the faculty of the College of Agriculture played an active part at the First National Congress of Coconut Planters which was held at Manila on February 21 to 26. Dean B. M. Gonzalez was a member of the program committee and chairman of one of the scientific conferences. Dr. R. B. Espino, who was the official delegate of the college to the congress, read a paper on copra driers, and Drs. L. B. Uichanco and G. O. Ocfemia discussed coconut pests and diseases.

The booth of the College of Agriculture was awarded the cup for the most artistic booth at the recent University Day celebration.

The Zamora Military Trophy was won by Company "C", Los Baños unit of the University Corps of Cadets, under the command of Cadet Captain Wenceslao Tingson, at the annual military drill competition held at Manila during the U. P. Day celebration.

Major Dean Hudnutt, of the General Staff Corps, Philippine Department, U. S. Army, made the annual inspection of the Los Baños unit on February 21.

The following awards were made for the present academic year to cadets of the Los Baños unit:

Loyalty medal	Cadet Captain Cornelio O. Mariano
Duty medal	Cadet Sargeant Amado Barroquillo
Honor medal	Cadet Major Salvador B. Oliveros
Efficiency medal	Cadet Captain Wenceslao Tingson
Leadership medal	Cadet Captain Pio N. Oabel
Marksmanship medal	Cadet First Lieutenant Felix Enrile

At the annual rifle and pistol competition, held at Manila on February 8, the Los Baños unit captured the first place in rifle, with Cadet Major Salvador B. Oliveros and Cadet First Lieutenant Felix Enrile tying for the highest individual record of 97 points.

The following athletic notes were furnished through the courtesy of Assistant Physical Director R. P. Tolentino, Jr.—

Students' tennis singles. The 1929-1930 Los Baños students' tennis-singles championship went to Santiago Ledesma of the Forest School. He defeated in the round-robin series of the tournament the three other semifinalists; namely, Charas Suebsaeng of the College of Veterinary Science and José Austria and Pee Tek Hap of the College of Agriculture. José Utzurrum, last year's singles champion, did not compete in this event.

Doubles. The best Forest School pair, Santiago Ledesma–Bayani Ongchangco, captured this year's tennis-doubles title. In order to do so, they had to beat such strong combinations as José Utzurrum–Raul Javellana, Isabelo Sonza–Damaso Pahud, Charas Suebsaeng–Sawat Viradeja, Pee Tek Hap–Ceferino Magno and José Austria–Rafael Rotor, last year's winner.

C. Alkan, Inc., donated medals to the tennis prize winners.

Faculty tennis. On February 2, 1930, a tennis team composed of U. P. Manila faculty members invaded Los Baños and lost very badly to the U. P. Los Baños faculty tennis team. The Manilans dropped seven of the eleven matches that were played; four resulted in draws. The visiting team consisted of Doctors Velarde, Mandanas, Adorable, Ayuyao, Ong, and Hernandez, and Professors Tan, Conklin, Moore, J. Teodoro, Manguerra, Austria, Zafra, and Gokhale. The home team was represented by Dean San Agustin, Doctors Francisco, Gomez, Tubangui, Adriano, Mondoñedo, A. L. Teodoro, and Espino, and Messrs. Sarao, Tolentino, Soliven, Baltazar, Yñiguez, Mabakiao, San Buenaventura, and Varona.

A return engagement between these two faculty tennis teams is scheduled to be held in Manila on a Sunday during the present month. President Palma promised to award a cup to the winning team.

Track and field. Listed below are the Aggies who made the University track and field team which won the 1929-1930 N. C. A. A. (National Collegiate Athletic Association) Track and Field Championships:

1. Pascual Andres
2. Leonardo Banaag
3. Eleuterio Enriquez
4. Amado Paggao
5. Eduardo Perez
6. Guillermo Manalo
7. Theodore Schuck
8. Pedro Yatar
9. José Zabarte, Jr.

The following Aggies represented the N. C. A. A. in the 1930 P.A.A.F. (Philippine Amateur Athletic Federation) National Championships held in Manila during the Carnival:

In baseball: Hermenegildo Farolan, Perfecto Ocampo, and Aniano Paner.

In basketball (for the University only): Alberto Elefano, Julito Marcos, and Briccio Reynoso.

In track and field: Pascual Andres, Guillermo Manalo, Amado Paggao, Theodore Schuck, and Pedro Yatar.

Worthy of special mention was the excellent showing of Pedro Yatar and Amado Paggao in the P.A.A.F. Track and Field Meet. Yatar broke all existing Philippine (Federation) records in the 1,500-meter run (4 minutes and 15.9 seconds) and in the 800-meter race (2 minutes and 1.3 seconds; this equals the Far Eastern Athletic Association record). He was likewise a member of the N.C.A.A. record-breaking 1,600-meter relay team (3 minutes and 29.8 seconds). Paggao was a close third in the 200-meter low hurdle event.

AN ANNOUNCEMENT:—SUMMER COURSES AT THE COLLEGE OF AGRICULTURE

The following courses will be given at the College of Agriculture, University of the Philippines, during the regular summer session, 1930. Classes will begin on Monday, March 31, and close on Thursday, May 29. Registration will open on Thursday, March 27, and close on Saturday, March 29.

DEPARTMENT OF AGRICULTURAL CHEMISTRY

Agricultural Chemistry

1b.—*General Chemistry.* Regular course. 7:30 a. m.–11:30 a. m. Lecture 5 and laboratory 15 hours, to be arranged by the instructor in charge. Prerequisite: Agricultural Chemistry 1a. Credit, 5 units. In charge: Mr. R. Moreno.

2a.—*Elementary Qualitative Analysis.* Regular course. 7:30 a. m.–11:30 a. m. Lecture 5 and laboratory 15 hours, to be arranged by the instructor in charge. Prerequisite: Agricultural Chemistry 1. Credit, 5 units. In charge: Dr. F. T. Adriano, Mr. R. Cruz, and Mr. F. A. Soliven.

3a.—*Organic Chemistry.* Regular course. 12 students. 7:30 a. m.–11:30 a. m. Lecture 5 and laboratory 15 hours, to be arranged by the instructor in charge. Prerequisite: Agricultural Chemistry 1. Credit, 5 units. Open only to students majoring in Agricultural Chemistry. Other students registering in this course should first secure approval of the Head of Department. In charge: Dr. F. O. Santos and Mr. E. Collado.

99.—*Special Problems.* By arrangement. In charge: Head of Department.

100.—*Undergraduate Thesis.* By arrangement. In charge: Head of Department.

Sugar Technology

1a.—*Cane Field Practice.* By arrangement. In charge: Prof. R. H. King.

DEPARTMENT OF AGRICULTURAL EDUCATION

Agricultural Education

1.—*Elementary Methods.* Regular course. 25 students. Recitation. 7–8 MTWThF and 9–10 Tues. Credit, 3 units.

2.—*Elementary Psychology.* Regular course. 25 students. Recitation. 8–9 MTWThF and 9–10 Thurs. Credit, 3 units. In charge: Miss H. Reed.

Above courses are open only to junior, senior, and graduate students.

DEPARTMENT OF AGRICULTURAL ENGINEERING

Agricultural Engineering

1c.—*Farm Surveying.* Regular course. 20 students. Laboratory. 8–11 TTh. Prerequisite: Mathematics 1 (5). Credit, 1 unit. In charge: Dr. A. Gordon.

4.—*Mechanical Drawing.* Regular course. 20 students. Laboratory. 1–4 MTWTh. Credit, 2 units. Open only to Sugar Technology students and students majoring in Agricultural Engineering. In charge: Mr. E. Ongsansoy.

5.—*Plane Surveying.* Regular course. 12 students. Lectures 11–12 TTh; laboratory 9–12 Sat. Prerequisite: Agricultural Engineering 3. Credit, 3 units. Students registering in this course should first secure approval of the Head of Department. In charge: Dr. A. Gordon and Mr. A. Ferrer.

99.—*Special Problems.* By arrangement. In charge: Head of Department.

Farm Experience B.—*Blacksmithing.* 20 students in each section. Section A, 2–5 MWF; B, 2–5 TThS; C, 7–10 MWF; D, 7–10 TThS. In charge: Mr. J. Bondoc.

Farm Experience C.—*Carpentry.* 20 students in each section. Section A, 2–5 TThS; B, 2–5 MWF; C, 7–10 TThS; D, 7–10 MWF. In charge: Mr. J. Bondoc.

Farm Experience H.—*Household Engineering.* 10 students. Section A, 7–10 MWF. In charge: Dr. A. Gordon.

Mathematics 1.—*Plane Trigonometry.* Regular course. Section A, 7–9 MWF; B, 7–9 TThS. Credit, 3 units. Open only to repeaters. In charge: Mr. B. C. de las Alas.

Mathematics 5.—*Elementary Mathematical Analysis.* Regular course. 25 students. Recitation, 8–10 MTWThF. Prerequisite: Mathematics 1. Credit, 5 units. Open only to Sugar Technology students. Other students registering in this course should first secure approval of the Head of Department. In charge: Prof. M. A. Roa.

Physics 1.—*General Physics.* Coaching course. Lectures only, 9–11 MWF. Credit, 5 units. In charge: Mr. A. Rocafort.

DEPARTMENT OF AGRONOMY

Agronomy

2.—*Elementary Soil Science.* Regular course. 30 students. Lectures only. Credit, 5 units. Open only to repeaters. In charge: Prof. I. Elayda.

4.—*Survey of Philippine Crops.* Regular course. 40 students. Lectures only. 10–12 MTWThF. Perequisite: Agronomy 2. Credit, 5 units. In charge: Mr. A. Varona.

10.—*Soil Physics and Management.* Regular course. 20 students. Lectures, 9–11 MWF; laboratory, 7–9 MWF and 7–10 TTh. Prerequisite: Agronomy 2. Credit, 5 units. In charge: Dr. R. L. Pendleton and Mr. T. Bandong.

14.—*Forage and Pasture Plants.* Regular course. 30 students. Lectures, 9–11 MWF; laboratory, 7–9 MWF and 7–10 TTh. Prerequisite: Agronomy 3. Credit, 5 units. In charge: Mr. V. Aragon.

99.—*Special Problems.* By arrangement. In charge: Head of Department.

100.—*Undergraduate Thesis.* By arrangement. In charge: Head of Department.

Farm Experience A.—*Summer Farm Practice.* Section A, 7–10 MTWThF; B, 7–10 MTWThF; C, 2–5 MTWThF; D, 2–5 MTWThF. In charge: Mr. A. B. Catambay.

DEPARTMENT OF ANIMAL HUSBANDRY

Animal Husbandry

5.—*Pedigrees.* Regular course. Lectures, 11–12 daily. Credit, 3 units. Open only to students majoring in Animal Husbandry. Other students registering in this course should secure approval of the Head of Department. In charge: Dr. M. Manresa.

103.—*Cattle Husbandry.* Regular course. Lectures, 7–8 MTWThF; laboratory, 8–11 MTWThF. Prerequisite: Animal Husbandry 3. Credit, 5 units. Open only to students majoring in Animal Husbandry. Other students registering in this course should first secure approval of the Head of Department. In charge: Dr. V. Villegas.

99.—*Special Problems.* By arrangement. In charge: Head of Department.

100.—*Undergraduate Thesis.* By arrangement. In charge: Head of Department.

DEPARTMENT OF ENTOMOLOGY

Including Zoölogy

Zoölogy 3.—*Introductory Economic Ichthyology.* Regular course. By arrangement. 10 students. Prerequisite: Zoölogy 1. Credit, 5 units. Open only to students majoring in Zoölogy. Other students registering in this course should first secure approval of the Head of Department. In charge: Dr. D. V. Villadolid.

Entomology 5.—*Insect Collection and Elementary Entomotaxy.* Regular course. By arrangement. 15 students. Prerequisite: Entomology 1. Credit, 3 units. Open only to students majoring in

Entomology. Other students registering in this course should first secure approval of the Head of Department. In charge: Dr. L. B. Uichanco.

Entomology (or Zoölogy) 99.—*Special Problems.* By arrangement. In charge: Head of Department.

Entomology (or Zoölogy) 100.—*Undergraduate Thesis.* By arrangement. In charge: Head of Department.

DEPARTMENT OF PLANT PATHOLOGY

Plant Pathology

1.—*Diseases of Plants.* Coaching course. By arrangement. Credit, 5 units. In charge: Dr. G. O. Ocfemia and Mr. M. S. Celino.

2.—*Methods of Plant Pathology.* Regular course. 8–12 MTWThF. Lecture 5 and laboratory 15 hours to be arranged by the instructor in charge. Open only to students majoring in Plant Pathology. Other students registering in this course should first secure approval of the Head of Department. Prerequisite: Plant Pathology 1. Credit, 5 units. In charge: Mr. E. F. Roldan and Mr. J. D. Atienza.

100.—*Undergraduate Thesis.* By arrangement. In charge: Head of Department.

DEPARTMENT OF PLANT PHYSIOLOGY

Plant Physiology

99.—*Special Problems.*—By arrangement. In charge: Head of Department.

100.—*Undergraduate Thesis.* By arrangement. In charge: Head of Department.

DEPARTMENT OF RURAL ECONOMICS

Rural Economics

1.—*Farm Bookkeeping and Accounting.* Regular course. 30 students. In charge: Mr. R. B. Rotor and Mr. M. V. Arnaldo.

Coaching courses are open only to students who received a grade of "4" or "incomplete" in their respective courses at the close of the present academic year.

A special course in poultry raising will be given this summer. This course is designed primarily for those interested in practical poultry production. The class is limited to a small number, and those intending to take the course should make application by letter to the Secretary of the College for reservation. Those who are actually engaged in farming will be given preference.

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